US006653815B2

(12) **United States Patent**
Watson et al.

(10) **Patent No.: US 6,653,815 B2**
(45) **Date of Patent: Nov. 25, 2003**

(54) **CORDLESS POWER TOOL SYSTEM**

(75) Inventors: **James B. Watson**, Fallston, MD (US); **Paul S. White**, Ellicott City, MD (US); **Christopher R. Yahnker**, Eldersburg, MD (US); **Daniel Puzio**, Baltimore, MD (US); **Thomas J. Bodine**, Jessup, MD (US); **Robert Bradus**, Bel Air, MD (US); **Daniele C. Brotto**, Baltimore, MD (US); **John E. Buck**, Cockeysville, MD (US); **Daniel J. White**, Baltimore, MD (US); **Samuel G. Woods**, Bel Air, MD (US); **Richard T. Walter**, Baldwin, MD (US); **Edward A. Harrison**, Bel Air, MD (US); **Adan Ayala**, Owings Mills, MD (US)

(73) Assignee: **Black & Decker Inc.**, Newark, DE (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/309,840**

(22) Filed: **Dec. 4, 2002**

(65) **Prior Publication Data**

US 2003/0117108 A1 Jun. 26, 2003

Related U.S. Application Data

(63) Continuation of application No. 09/963,809, filed on Sep. 26, 2001, now Pat. No. 6,515,451, which is a continuation of application No. 09/732,145, filed on Dec. 7, 2000, now Pat. No. 6,304,058, which is a continuation-in-part of application No. 09/579,940, filed on May 26, 2000, now Pat. No. 6,329,788, which is a continuation of application No. 09/133,923, filed on Aug. 13, 1998, which is a continuation-in-part of application No. 09/133,924, filed on Aug. 13, 1998, now Pat. No. 6,057,608.

(51) **Int. Cl.**[7] **H02J 7/00**
(52) **U.S. Cl.** **320/114**; 320/117
(58) **Field of Search** 320/114, 117, 320/107, 113, 112, 116; 307/43, 64, 66; 429/96, 97

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,962,062	A	11/1960	Winkler et al.	143/43
3,262,472	A	7/1966	McCarty et al.	143/43

(List continued on next page.)

FOREIGN PATENT DOCUMENTS

DE	39 19 702	11/1991
DE	44 03 189	11/1991

(List continued on next page.)

OTHER PUBLICATIONS

1997 DeWalt Catalog, p. 18.
Makita 1997 Pocket Catalog, pp. 11,16.

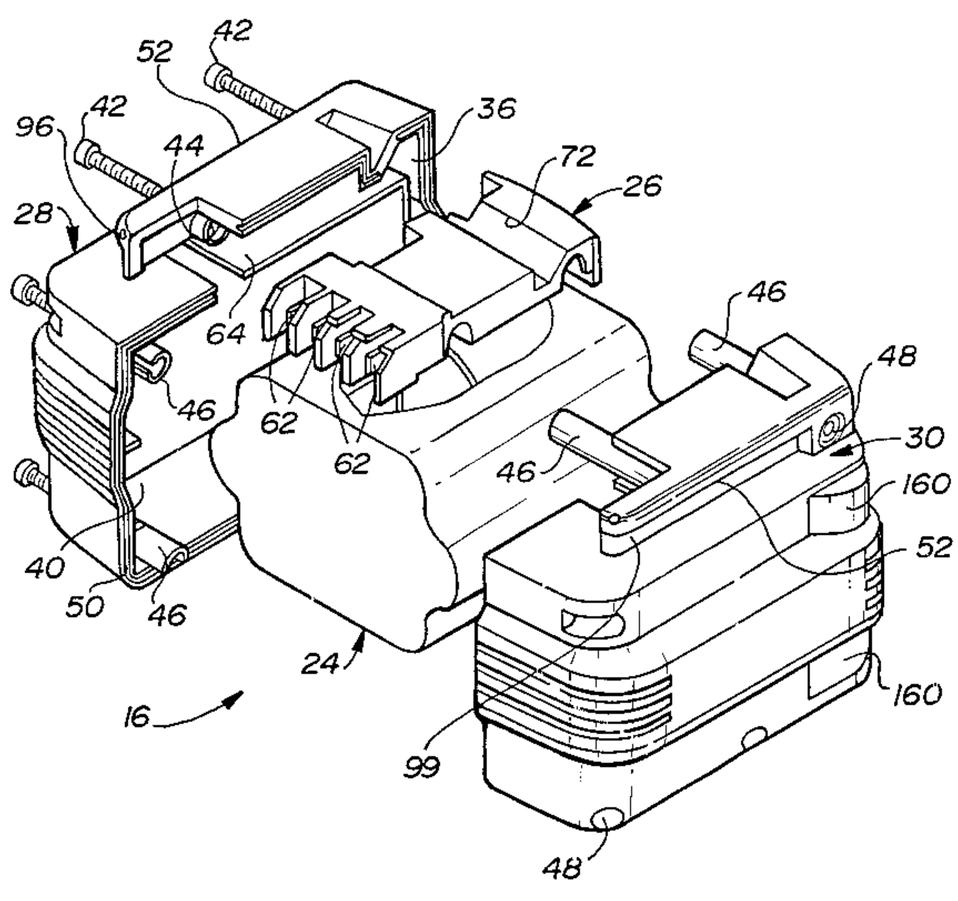
(List continued on next page.)

Primary Examiner—Lawrence Luk
(74) *Attorney, Agent, or Firm*—Harness, Dickey & Pierce, P.L.C.

(57) **ABSTRACT**

A system of cordless power tools includes a cordless power tool adapted to removably receive a rechargeable battery pack. The system further includes a battery pack charger and a converter for converting AC electricity to DC electricity. A battery pack interface block is captured between clam shell halves of a battery pack housing and includes a plurality of male blade terminals. The male blade terminals are received within recessed female terminals of a tool terminal block and similarly received by recessed female terminals of the charger. The tool terminal block further includes a pair of male terminals which engage recessed female terminals of the converter.

22 Claims, 14 Drawing Sheets



U.S. PATENT DOCUMENTS

3,292,673	A	12/1966	Gregory	143/43
3,447,577	A	6/1969	Burrows et al.	143/43
3,706,332	A	12/1972	George	143/159
3,730,239	A	5/1973	Kaman et al.	143/159
3,757,194	A	9/1973	Weber et al.	320/2
3,883,789	A	5/1975	Achenbach et al.	320/2
3,887,394	A	6/1975	Kaye	429/99
3,952,239	A	4/1976	Owings et al.	320/113
3,973,179	A	8/1976	Weber et al.	320/2
4,221,051	A	9/1980	Glass	30/377
4,321,523	A	3/1982	Hammel	320/14
4,353,165	A	10/1982	Albery	30/376
4,516,324	A	5/1985	Heininger, Jr. et al.	30/377
4,555,849	A	12/1985	Ando et al.	30/388
4,616,169	A	10/1986	Proffitt	320/2
4,847,513	A	7/1989	Katz et al.	307/149
4,856,394	A	8/1989	Clowers	83/56
4,982,501	A	1/1991	Sauerwein et al.	30/376
5,010,651	A	4/1991	Techter et al.	30/376
5,140,249	A	8/1992	Linder et al.	320/2
5,208,525	A	5/1993	Lopic et al.	320/2
5,381,602	A	1/1995	Matzo et al.	30/377
5,391,972	A	2/1995	Gardner et al.	320/115
D363,656	S	10/1995	Gierke	D8/66
5,454,167	A	10/1995	Albery	30/377
5,504,412	A	4/1996	Chan et al.	320/2
5,508,123	A	4/1996	Fan	429/96
5,517,763	A	5/1996	Schilling et al.	30/376
5,553,675	A	9/1996	Pitzen et al.	173/217
5,589,288	A	12/1996	Coulson et al.	429/96
5,671,815	A	9/1997	Kabatnik et al.	173/217
5,792,573	A *	8/1998	Pitzen et al.	429/97
5,881,823	A	3/1999	Kabatnik et al.	173/217
6,075,341	A *	6/2000	White et al.	320/114

FOREIGN PATENT DOCUMENTS

DE	91 15 492.8		4/1992
DE	93 11 901.1		8/1993
DE	93 19 361.0		12/1993
DE	196 04 346	A1	8/1996
DE	34 29 095		1/1997
DE	295 13 330		2/1997
EP	0 238 718		11/1986
EP	0 374 600	B1	8/1995
EP	1 017 149	A2	7/2000
EP	1 025 961	A1	8/2000
EP	1 017 149	A3	4/2001
GB	2 302 051		1/1997
JP	0281880		11/1989

OTHER PUBLICATIONS

Milwaukee Heavy Duty Electric Tools For Contractors and Industry, 1997 Catalog, p. 24.

Makita 1993 Catalog, four pages including cover page, pp. 17 and 19, and back page (dated 1993).

* cited by examiner

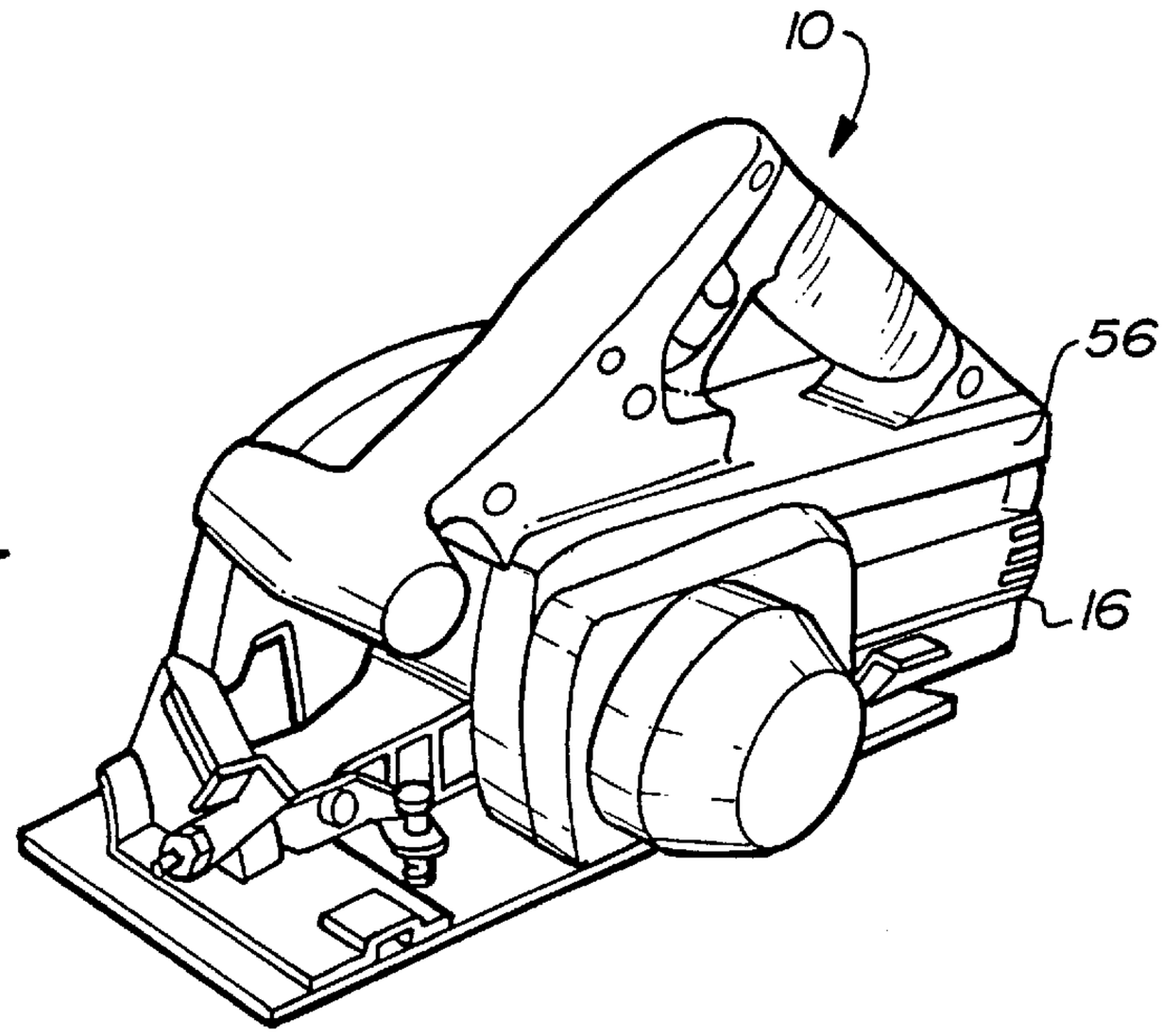

10
56
16

Fig-1A

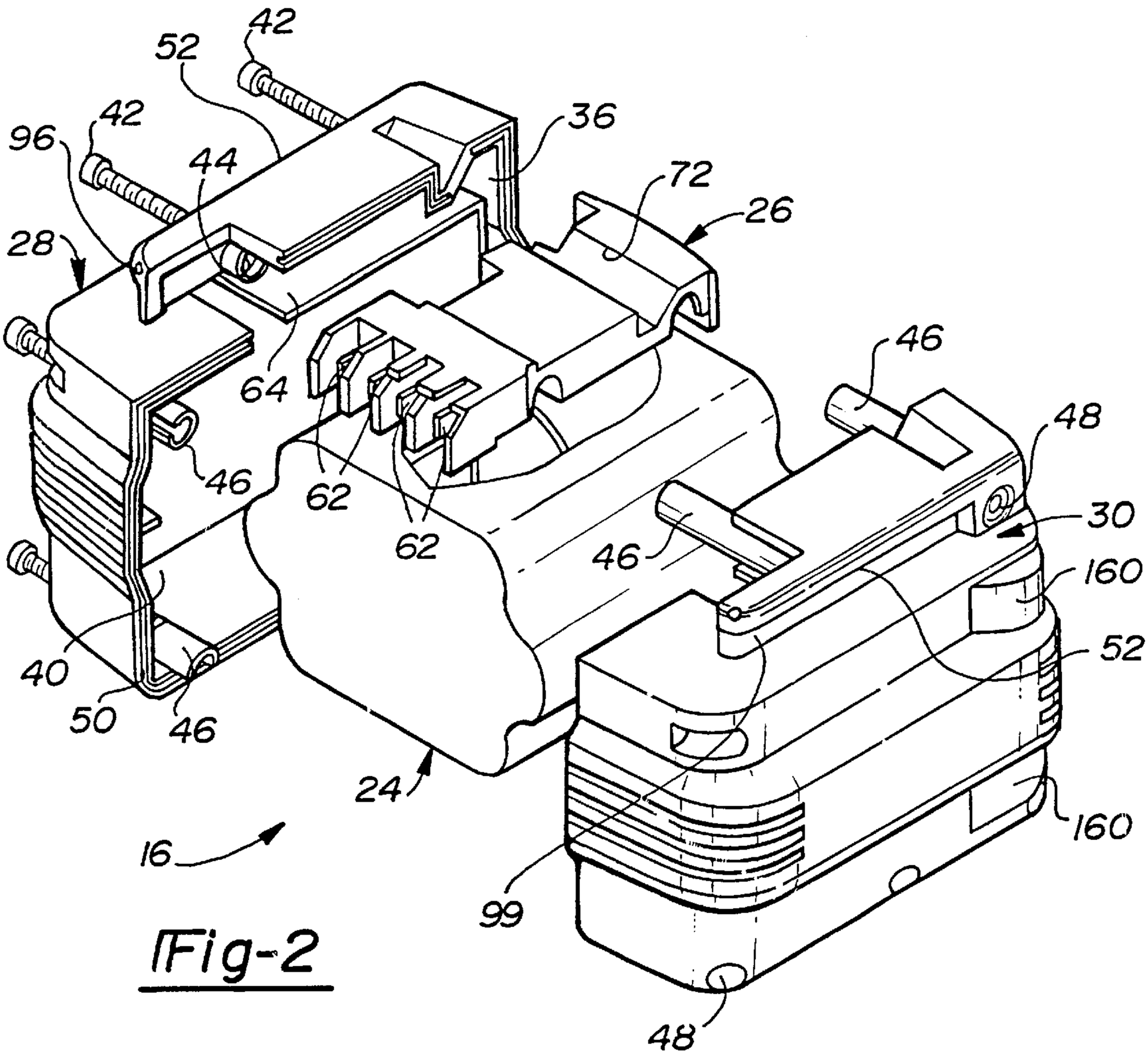

42
52
42
96
44
36
72
26
28
64
46
62
62
46
48
46
30
160
40
52
50
46
24
16
99
160
48

Fig-2

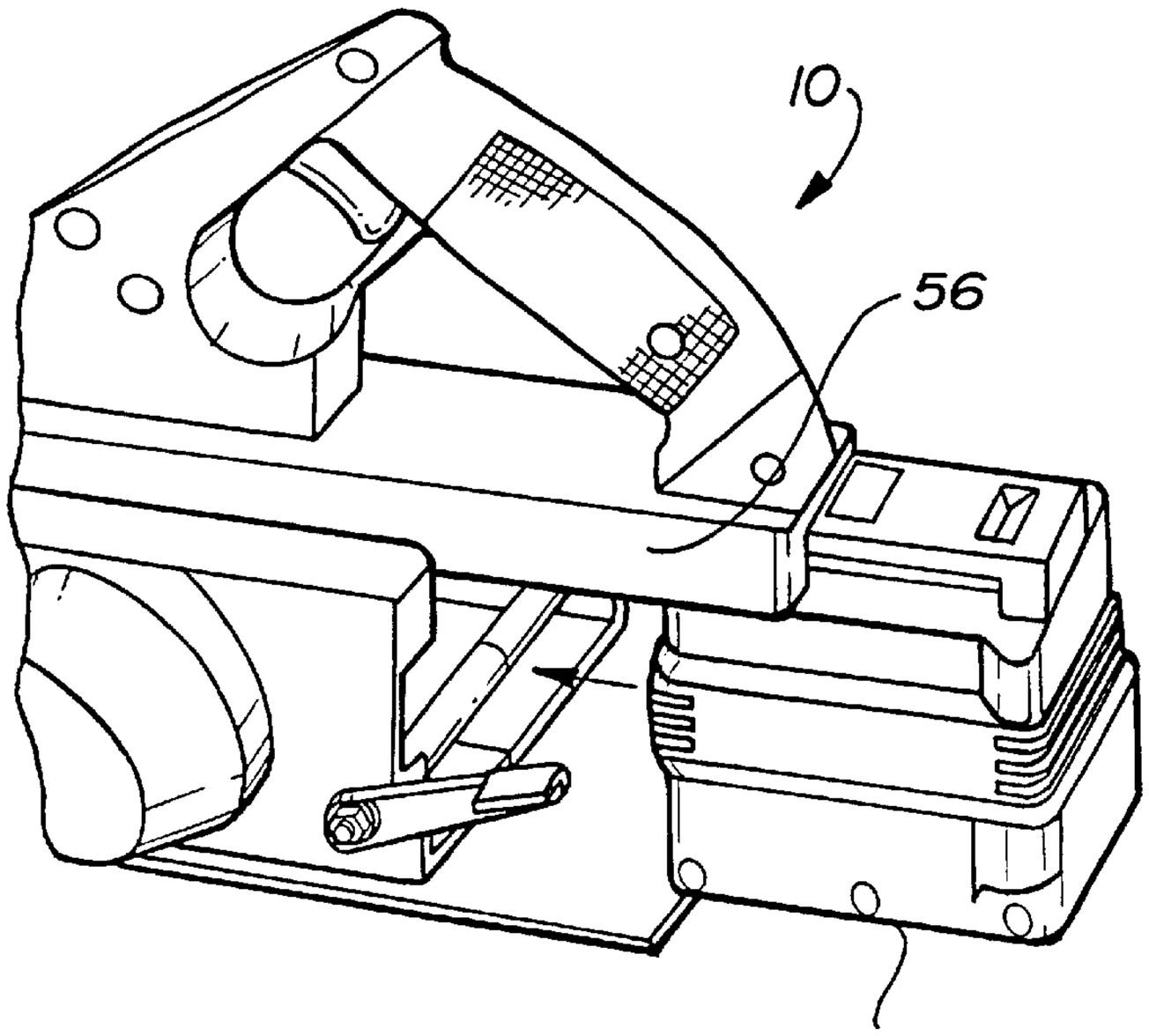


Fig-1B

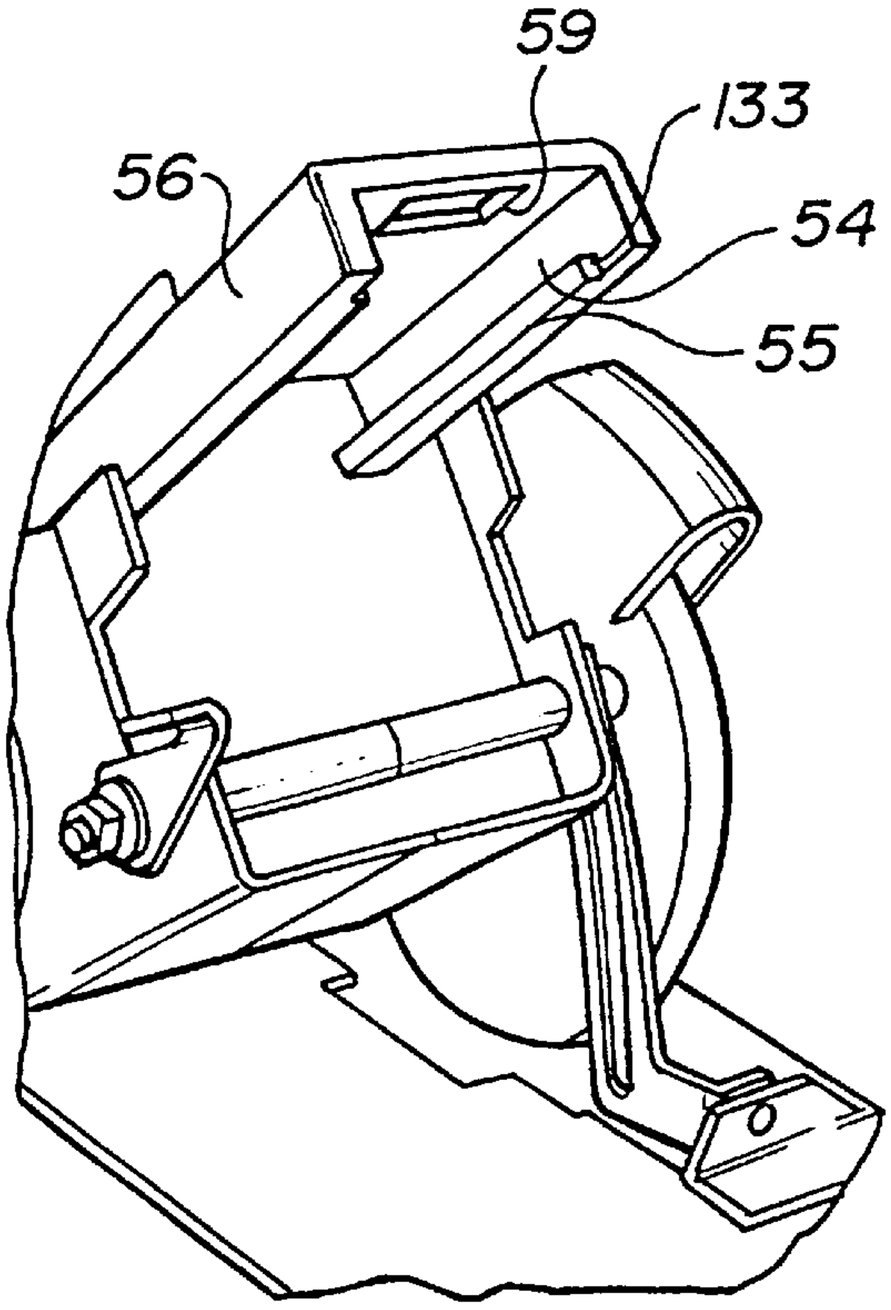


Fig-1C

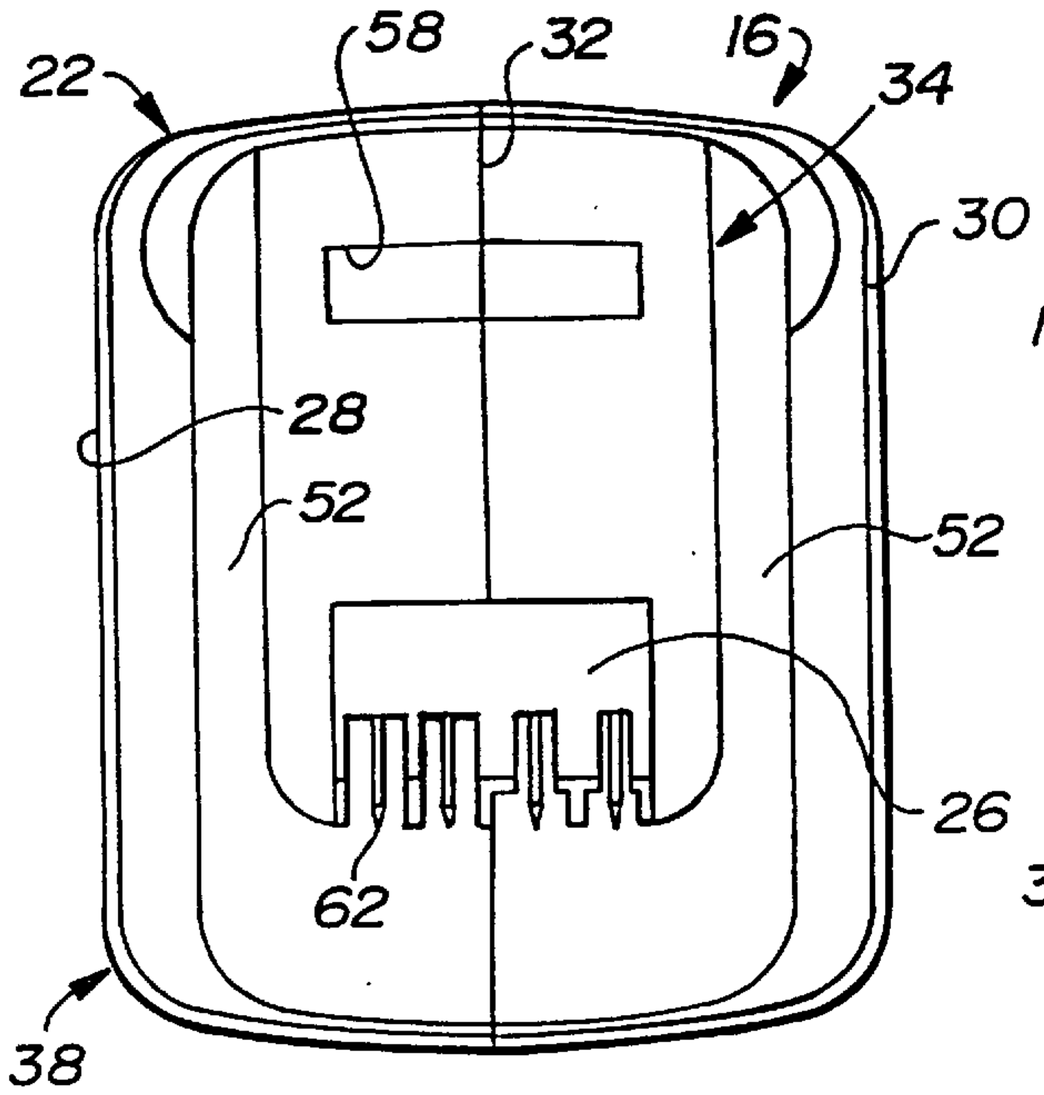


Fig-3

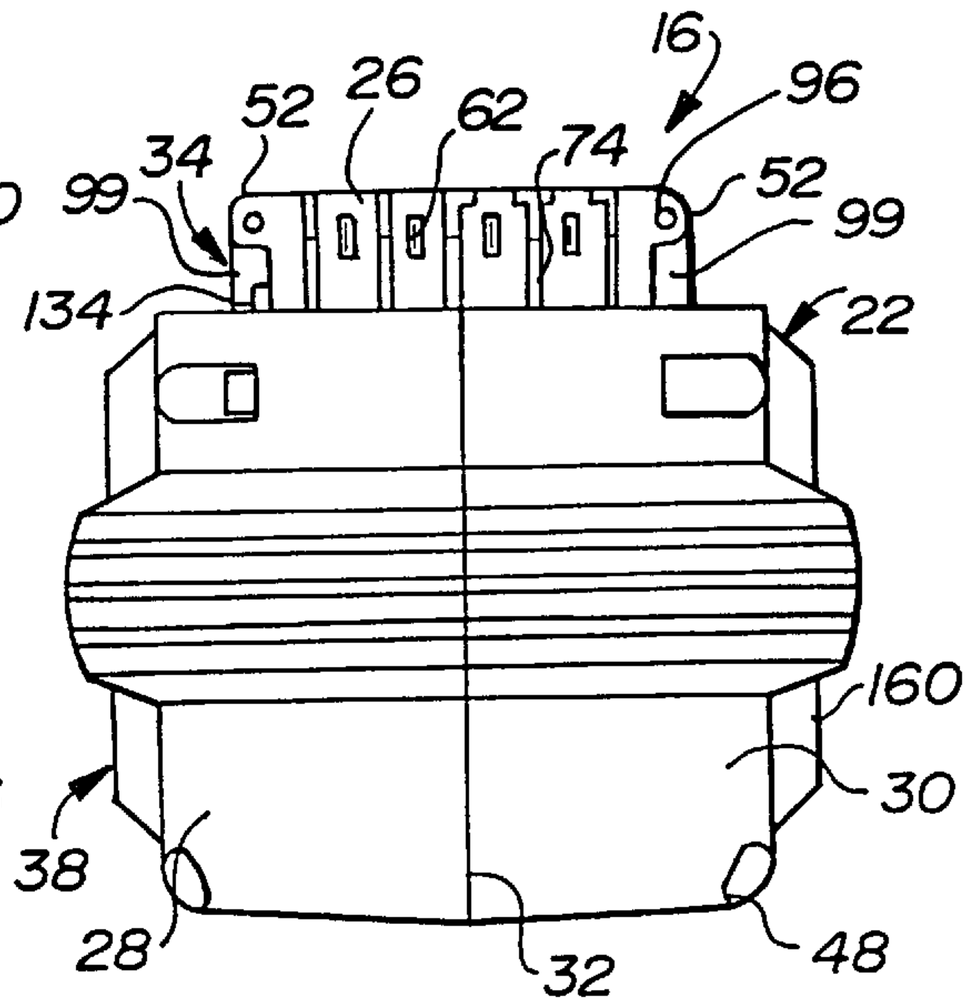


Fig-4

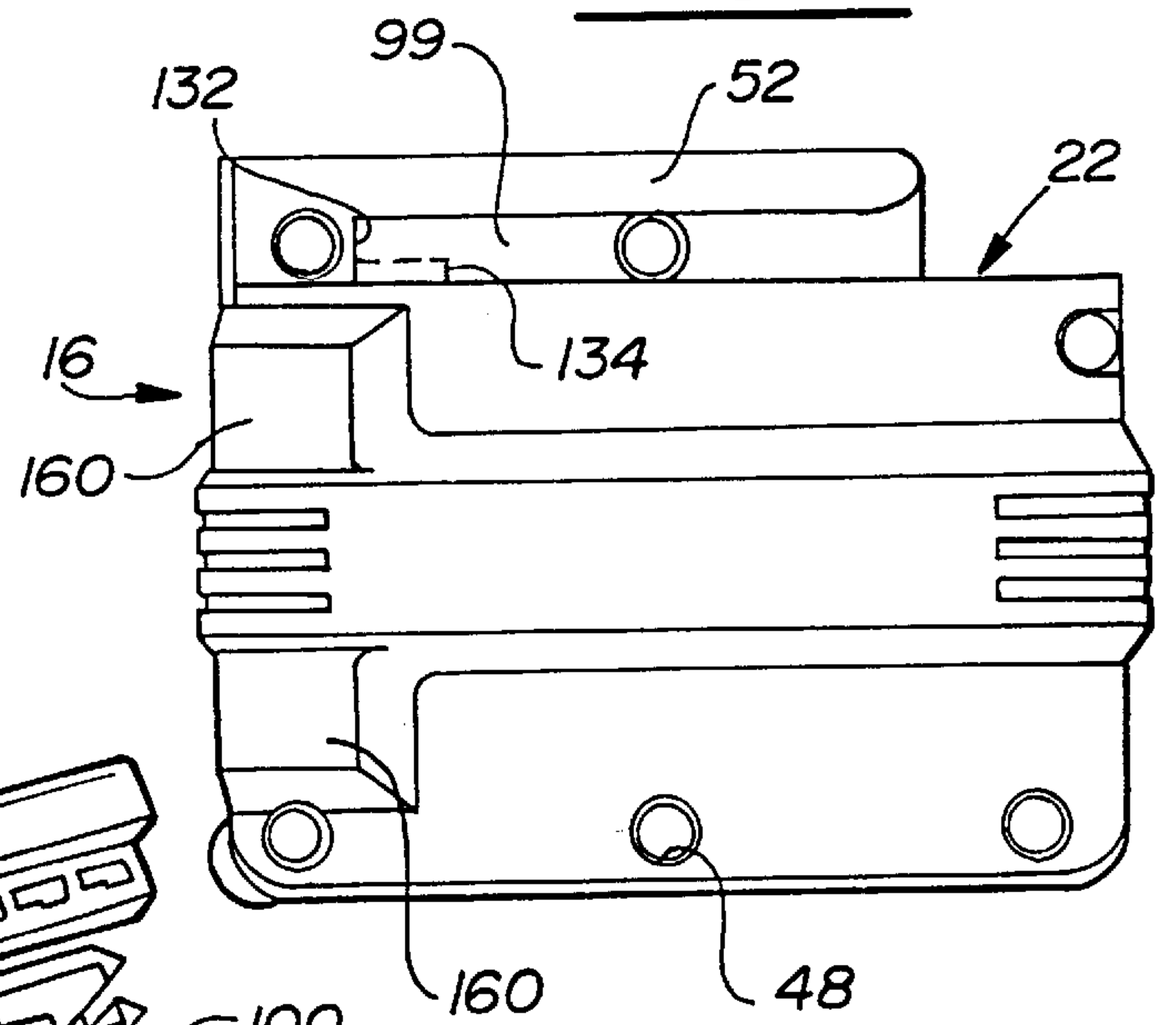


Fig-5

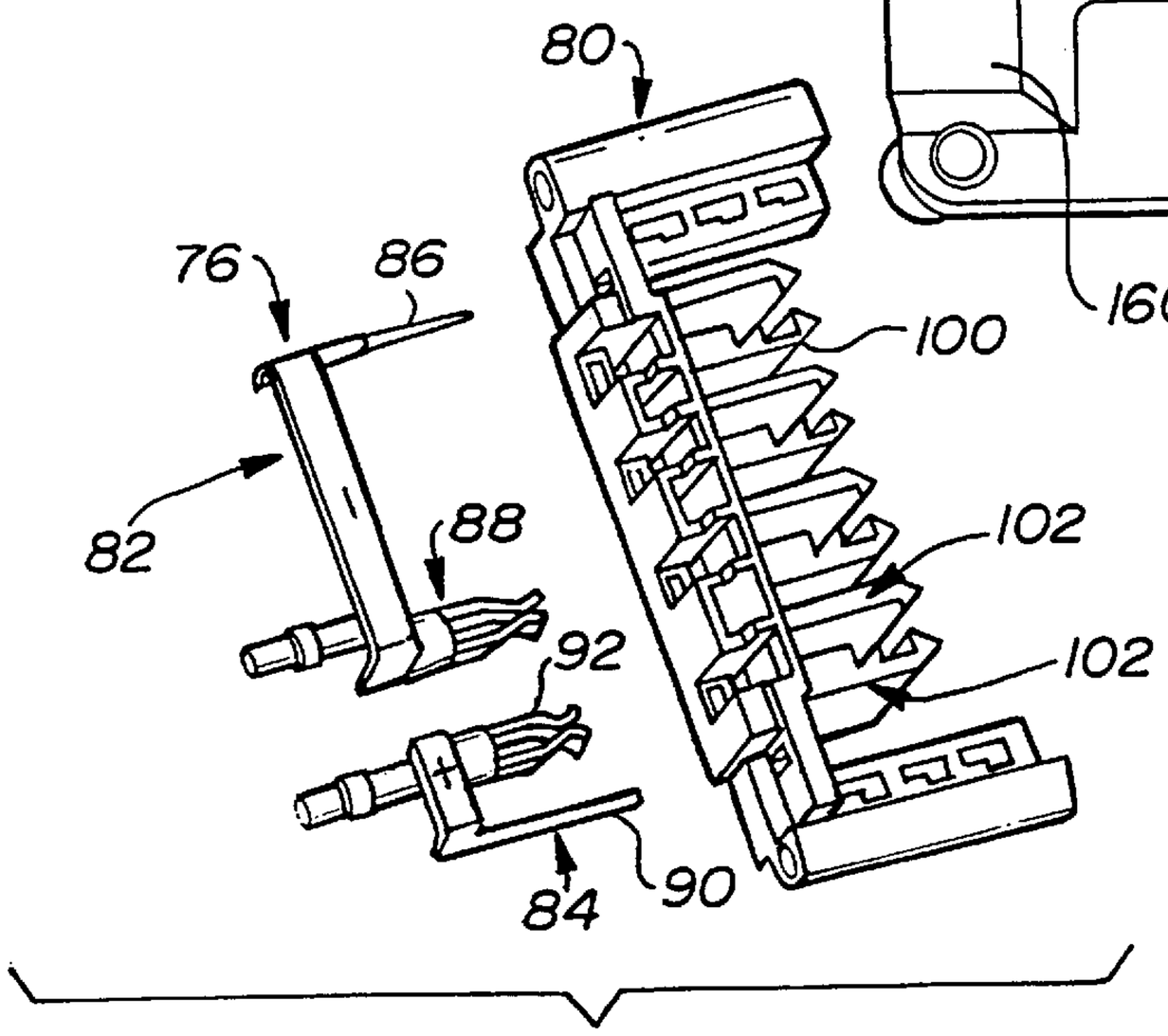


Fig-6A

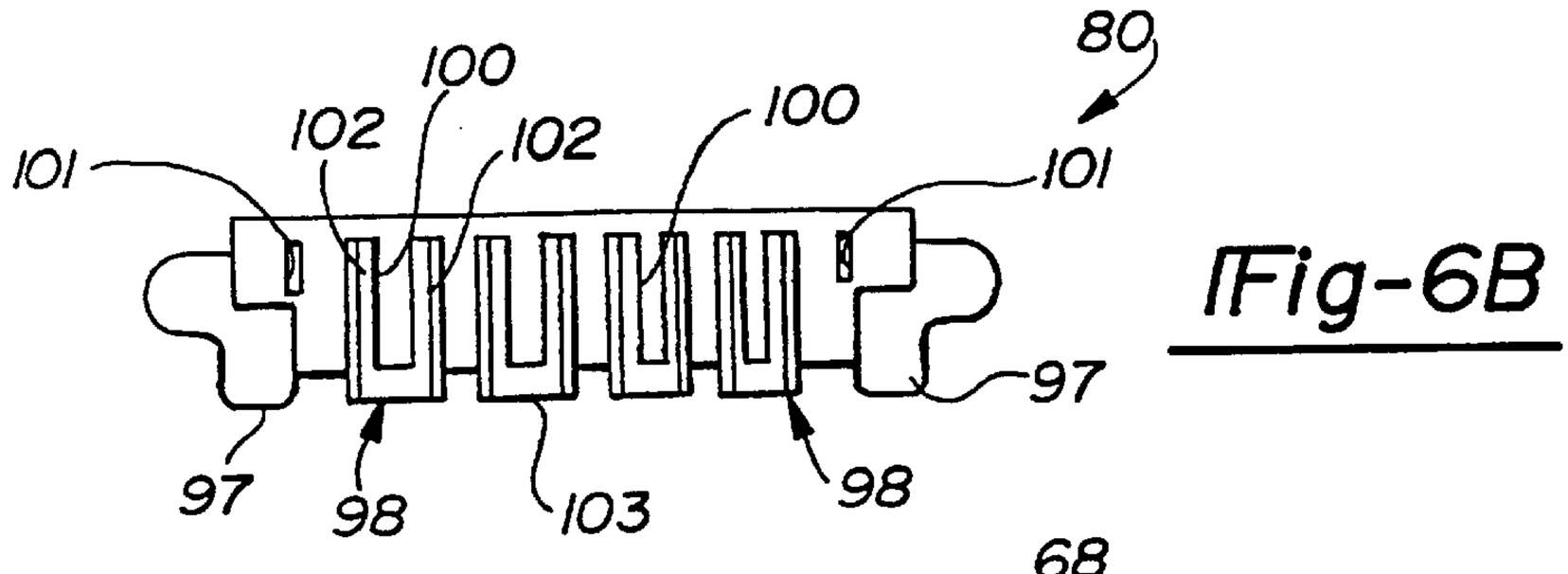


Fig-6B

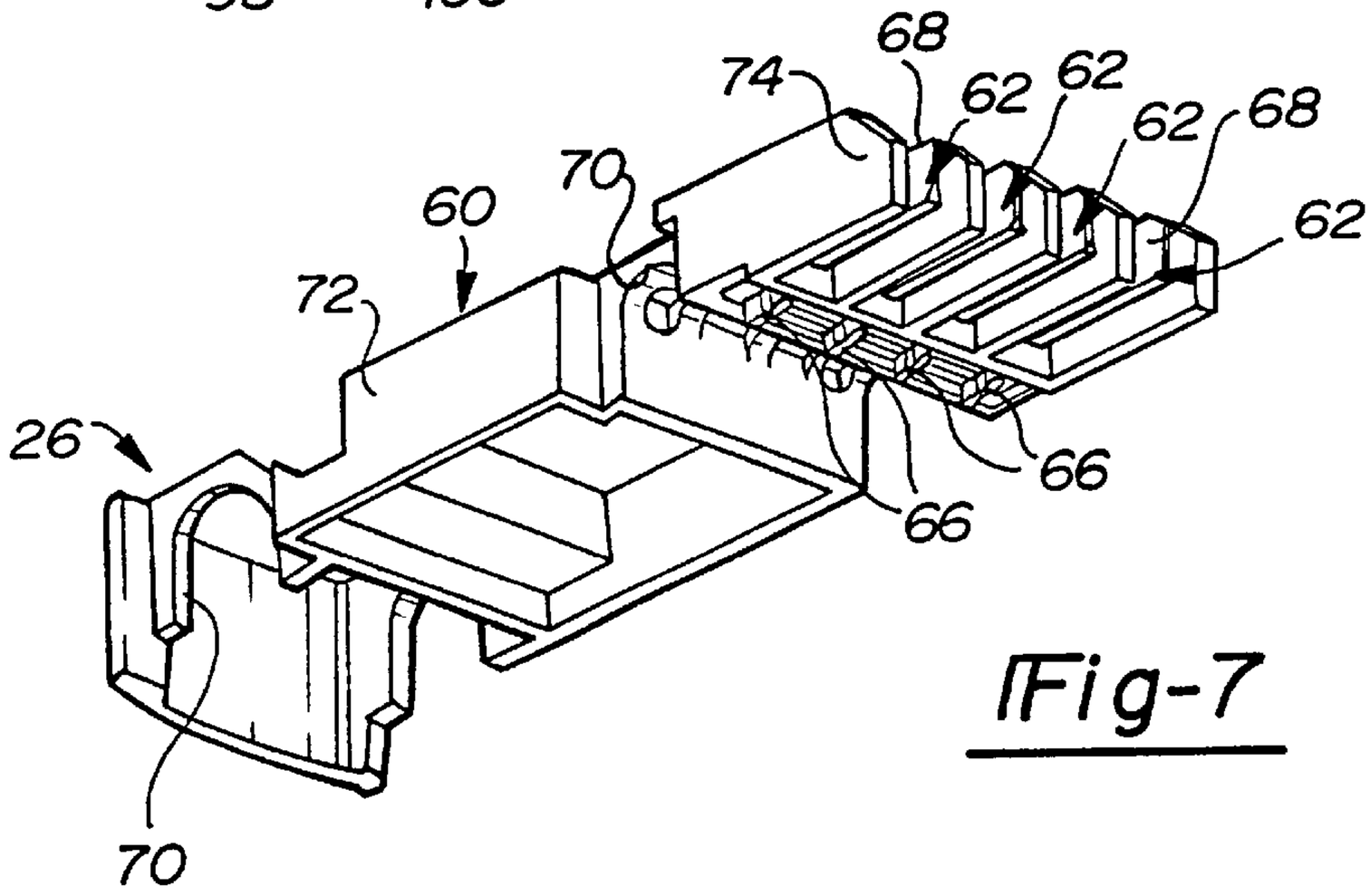


Fig-7

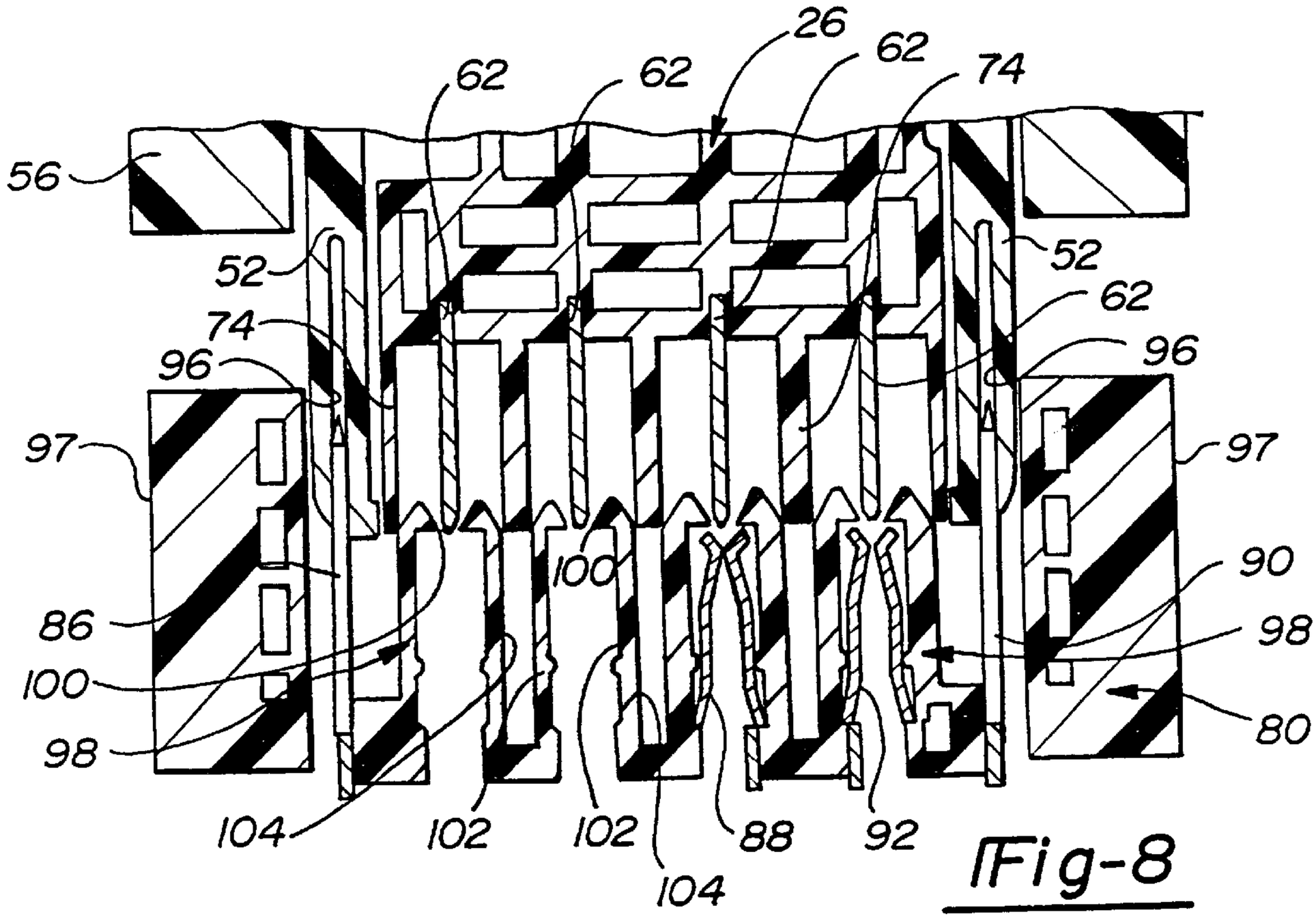


Fig-8

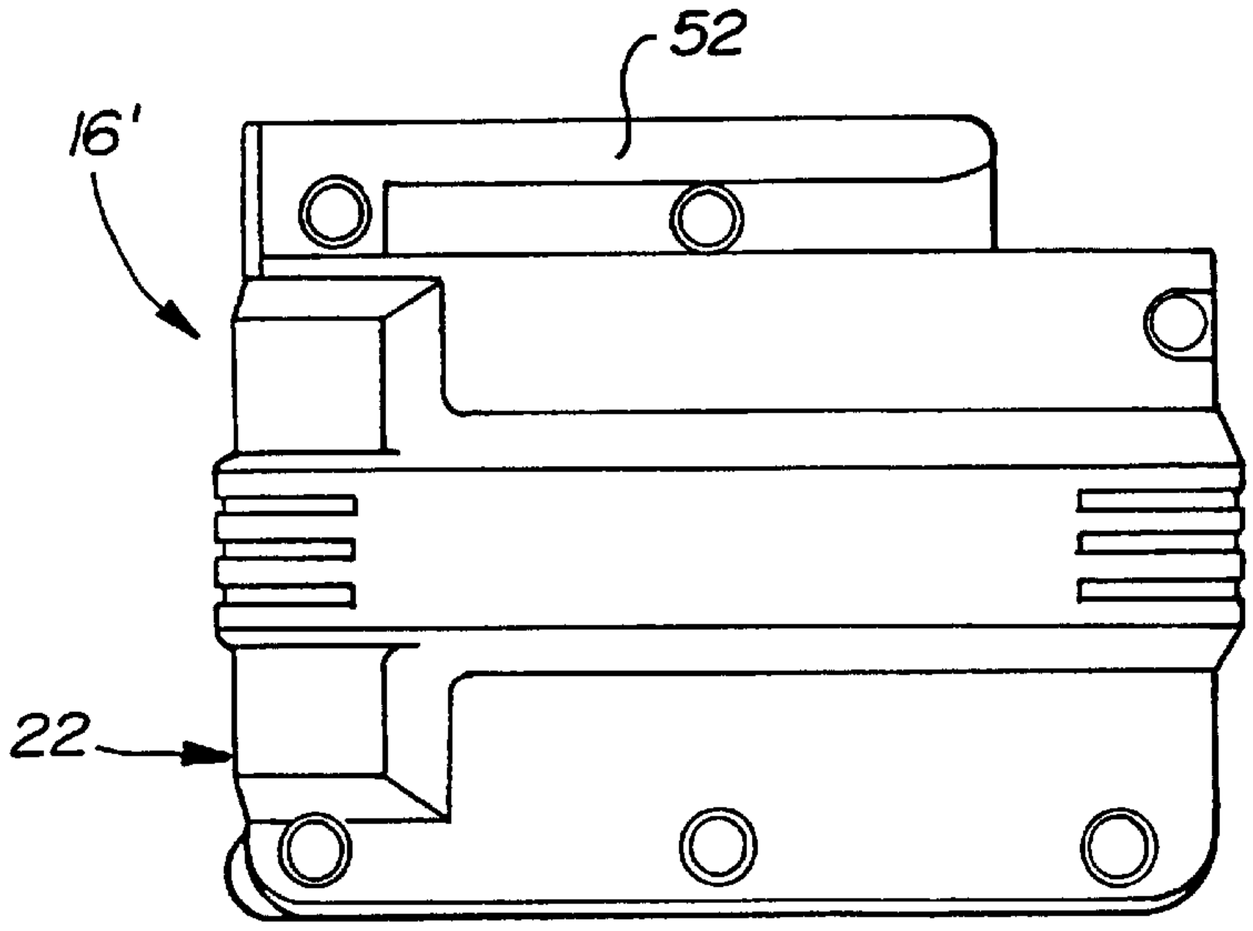


Fig-9

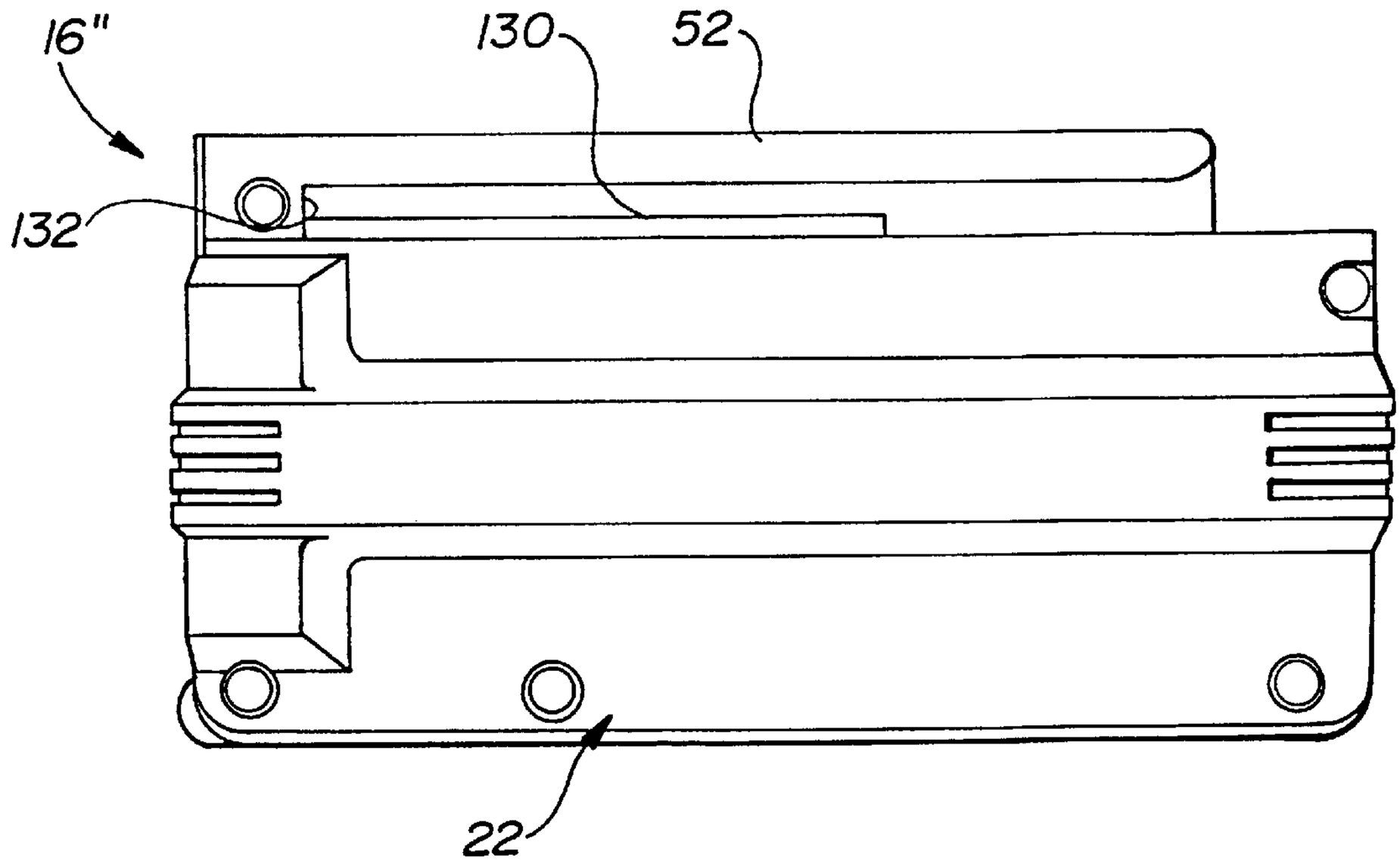


Fig-10

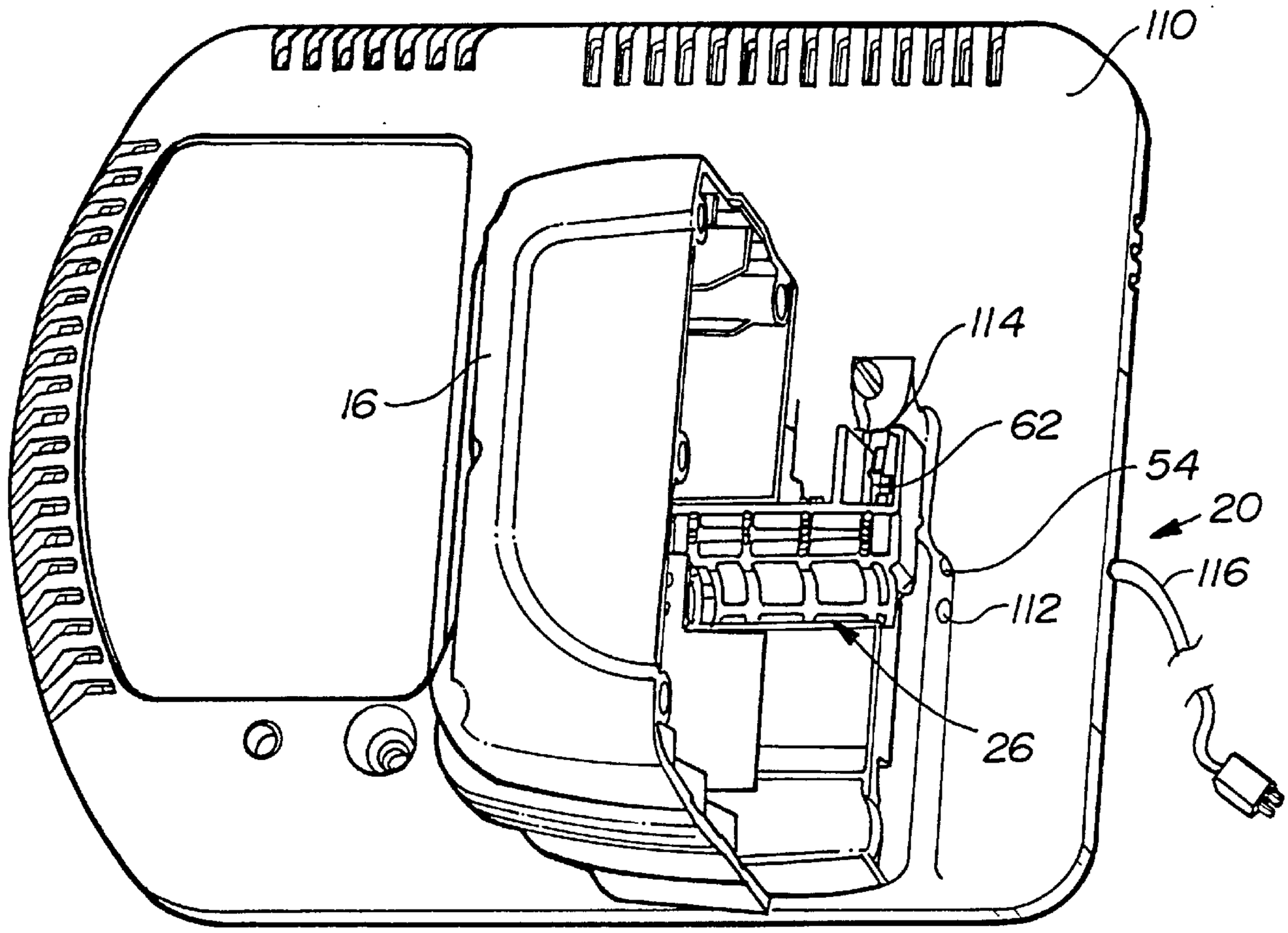


Fig-11

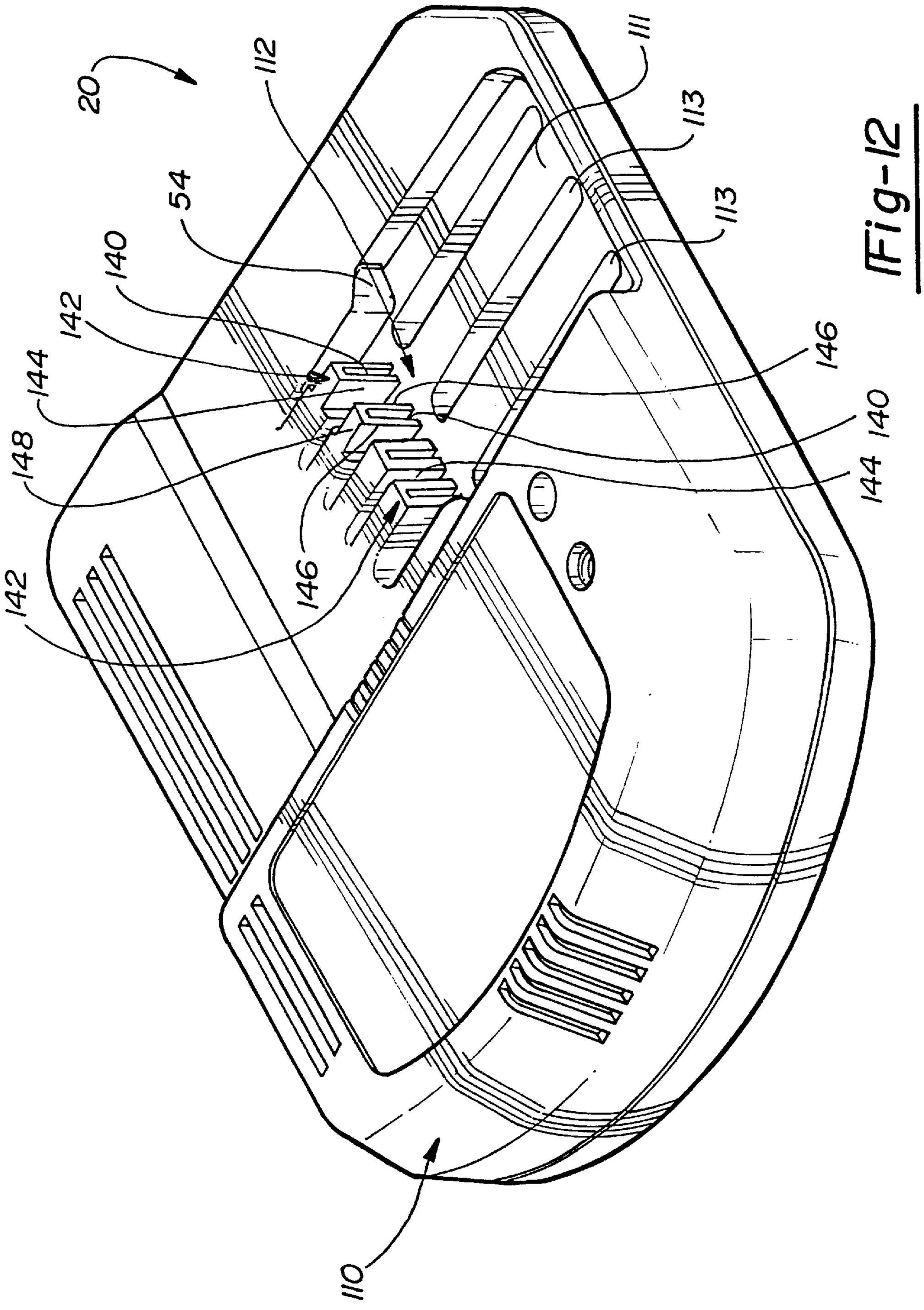


Fig-12

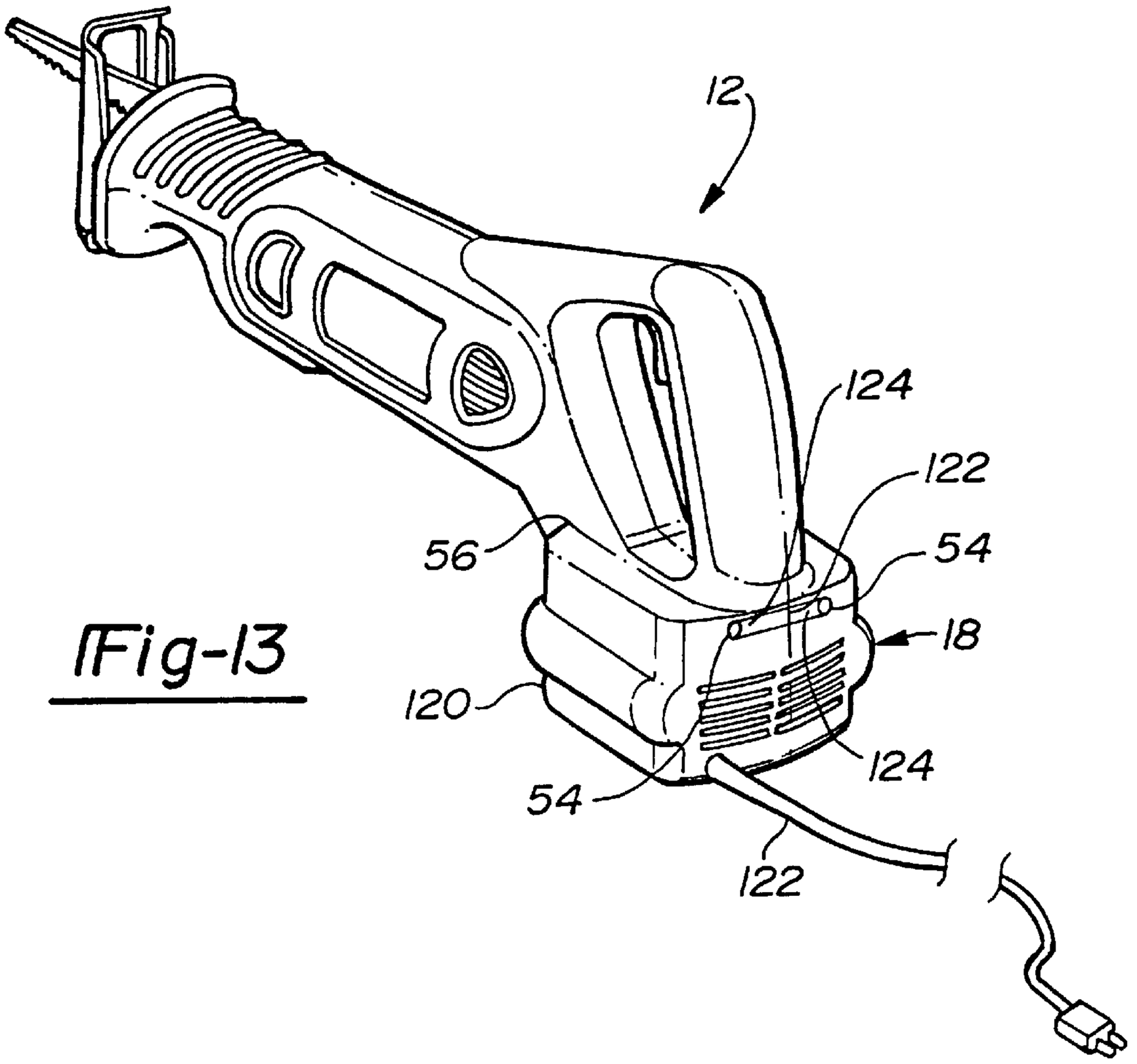


Fig-13

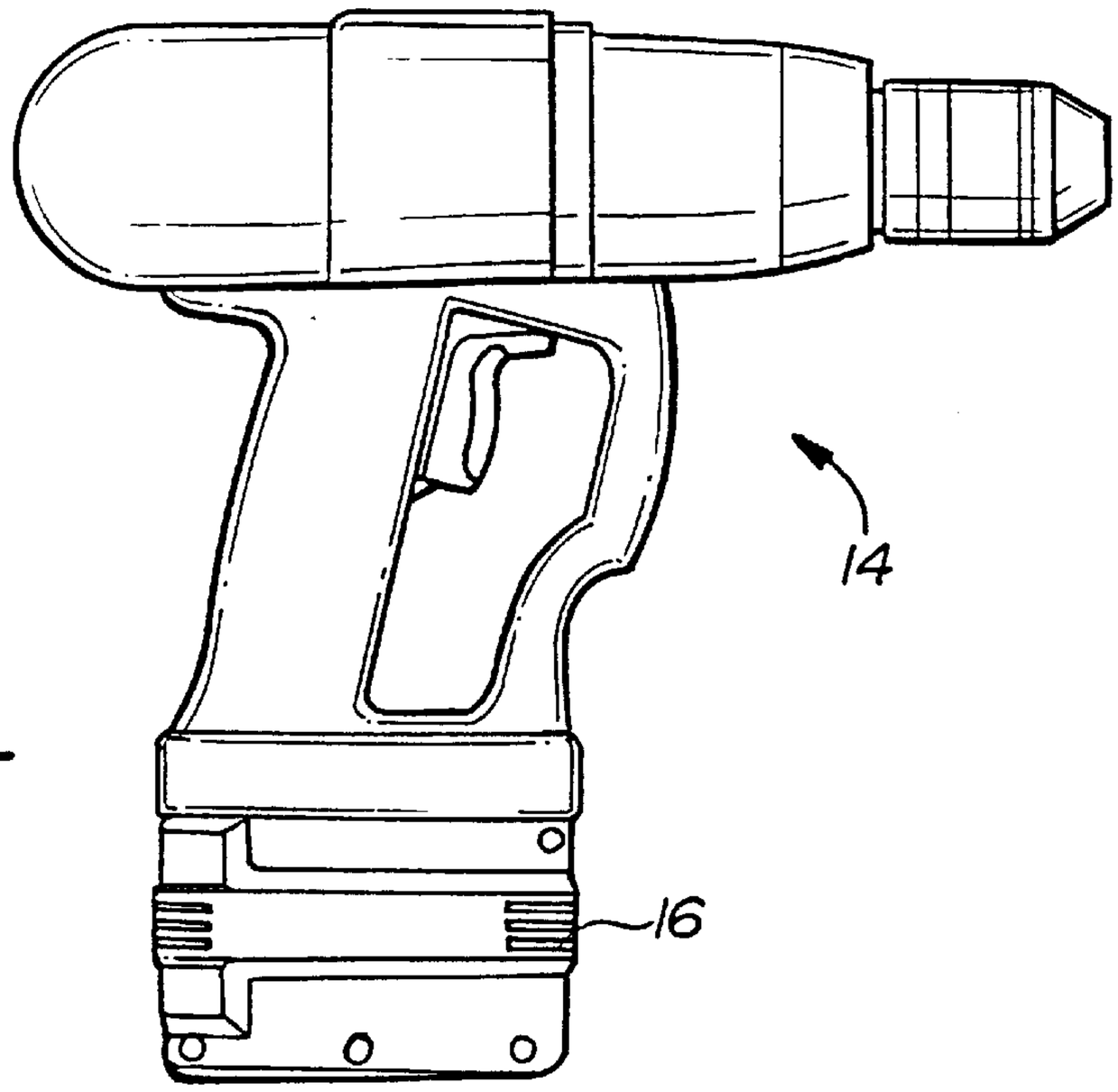


Fig-15

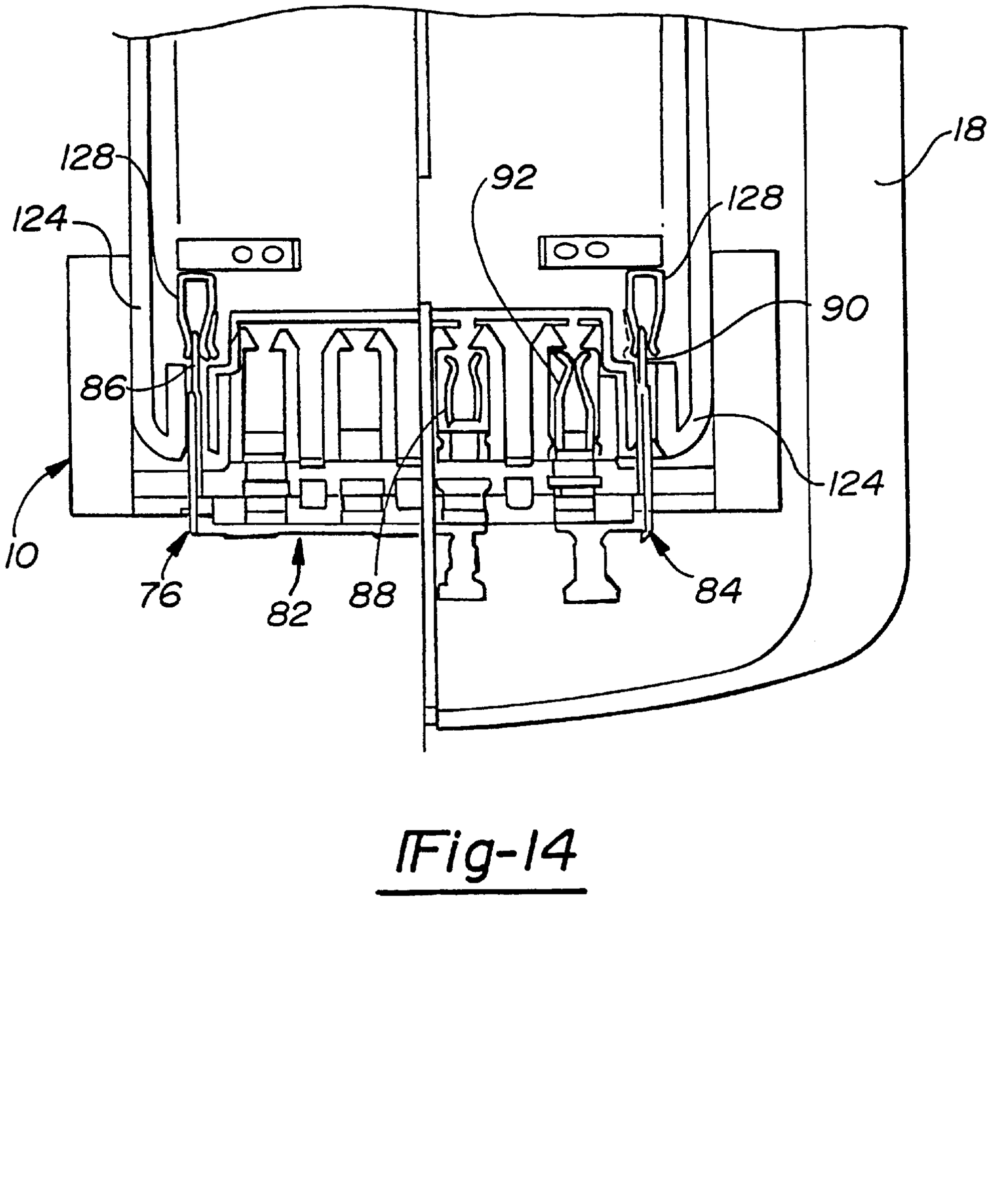


Fig-14

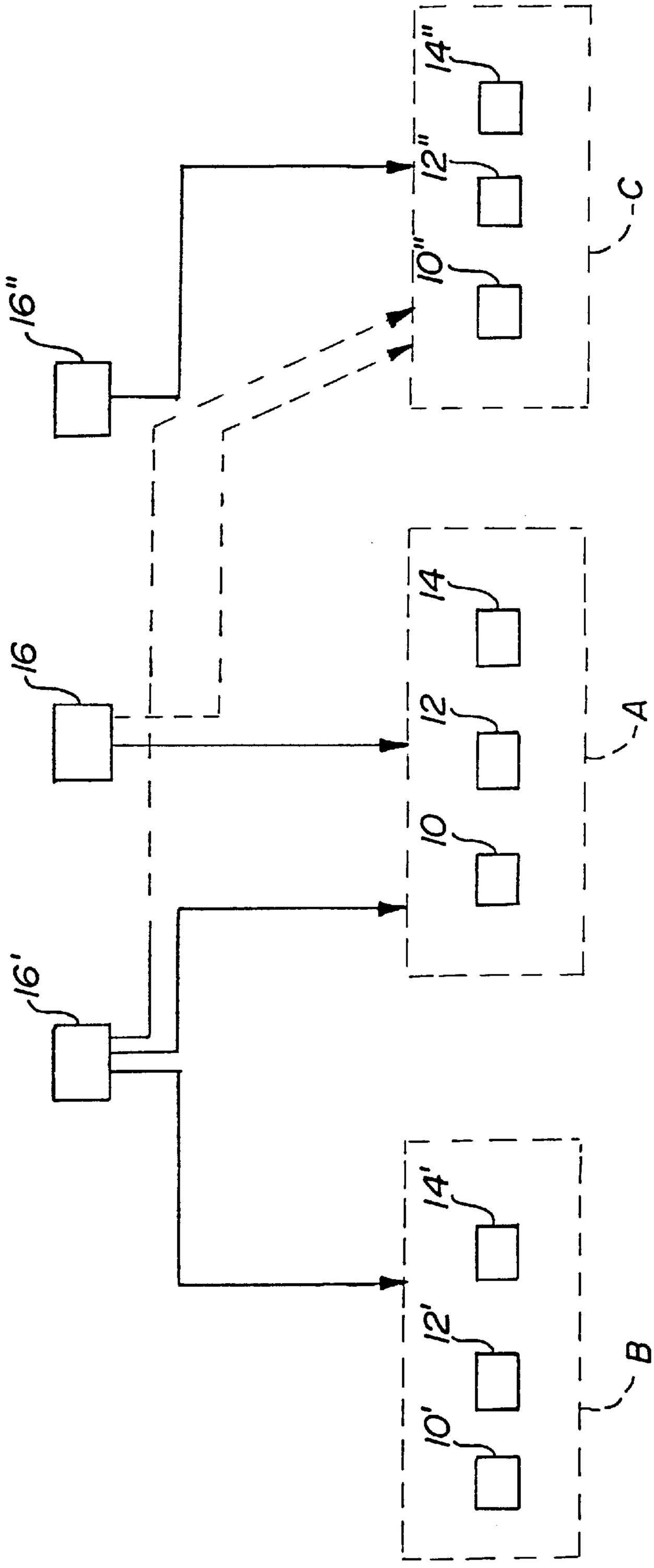


Fig-16

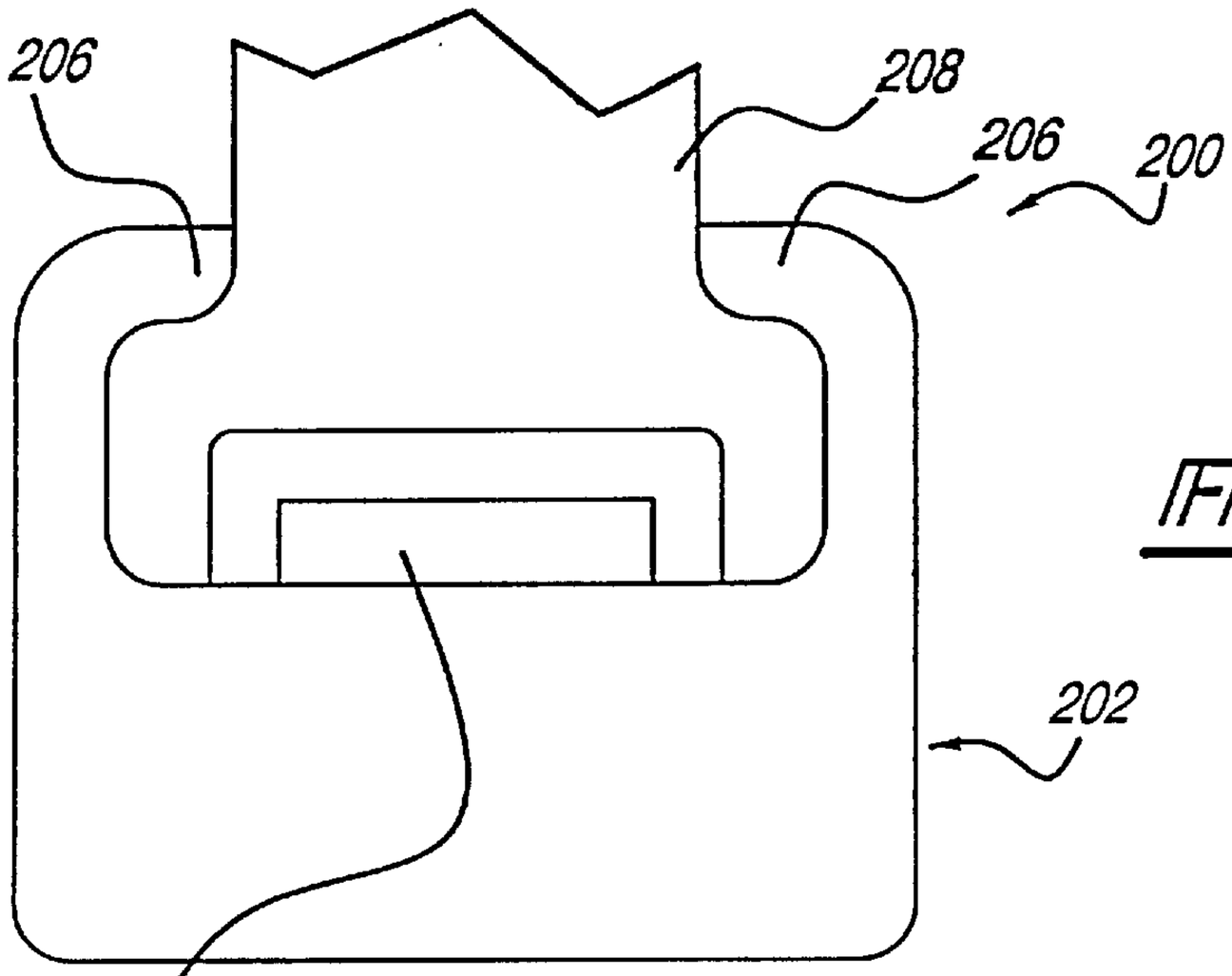


Fig - 17

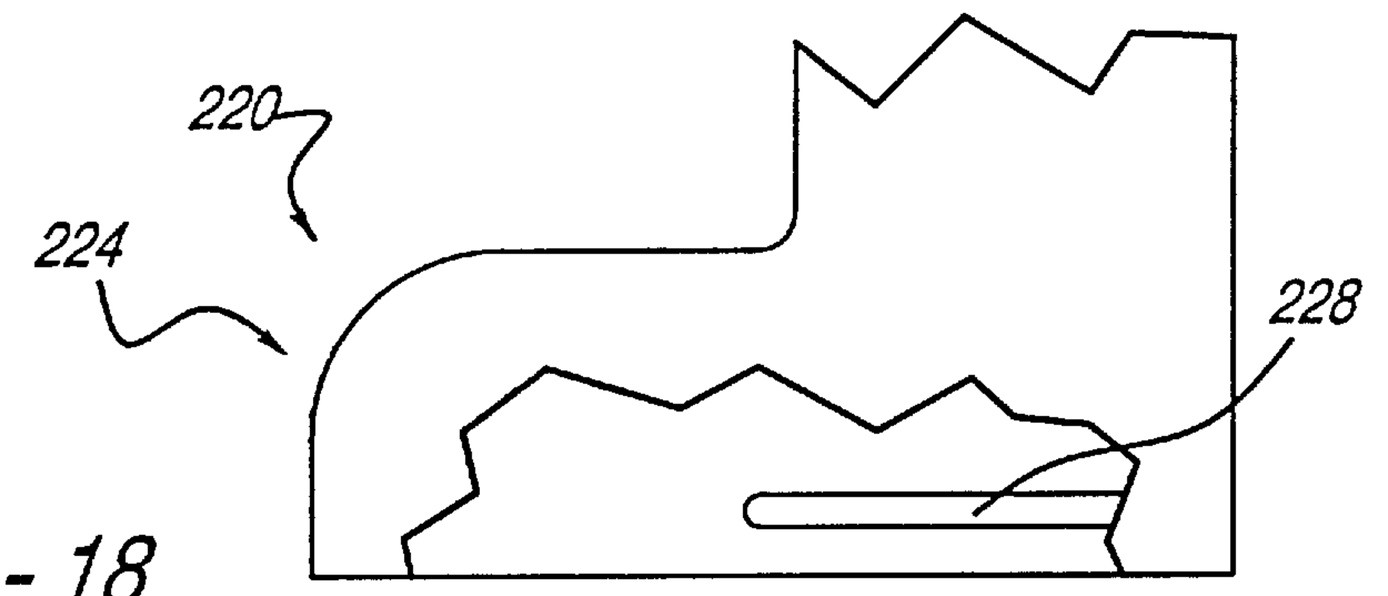


Fig - 18

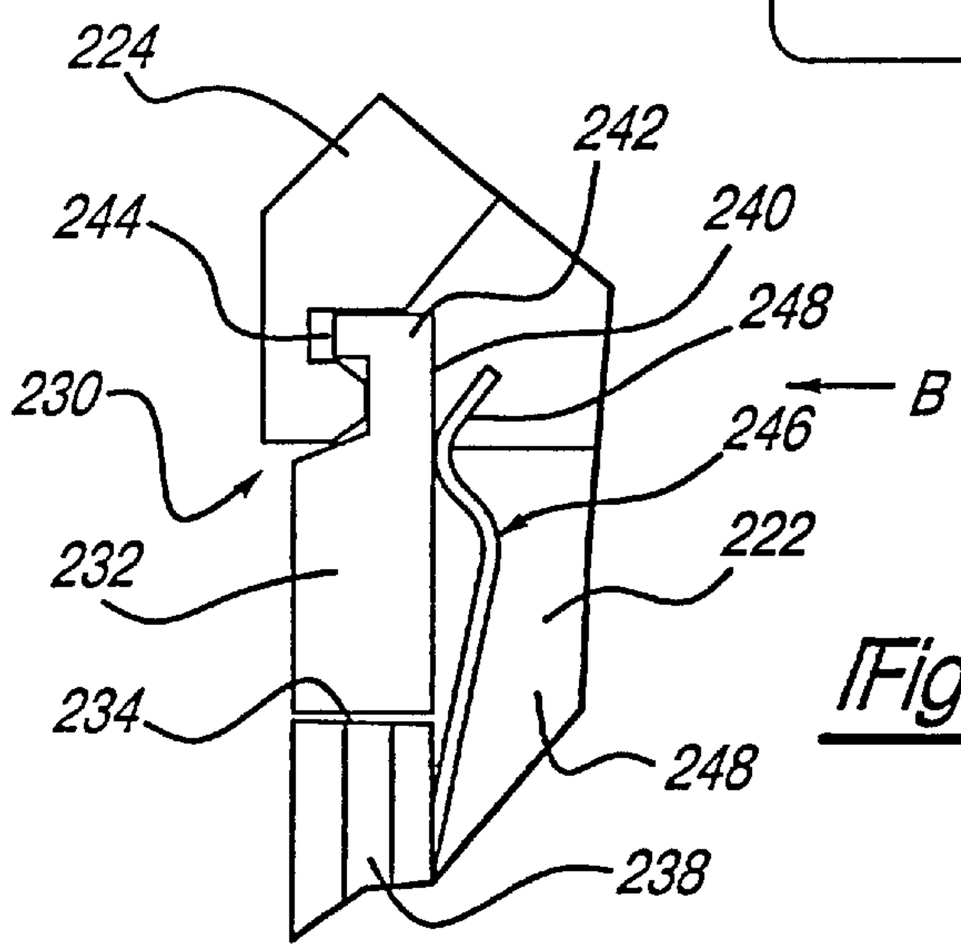


Fig - 19

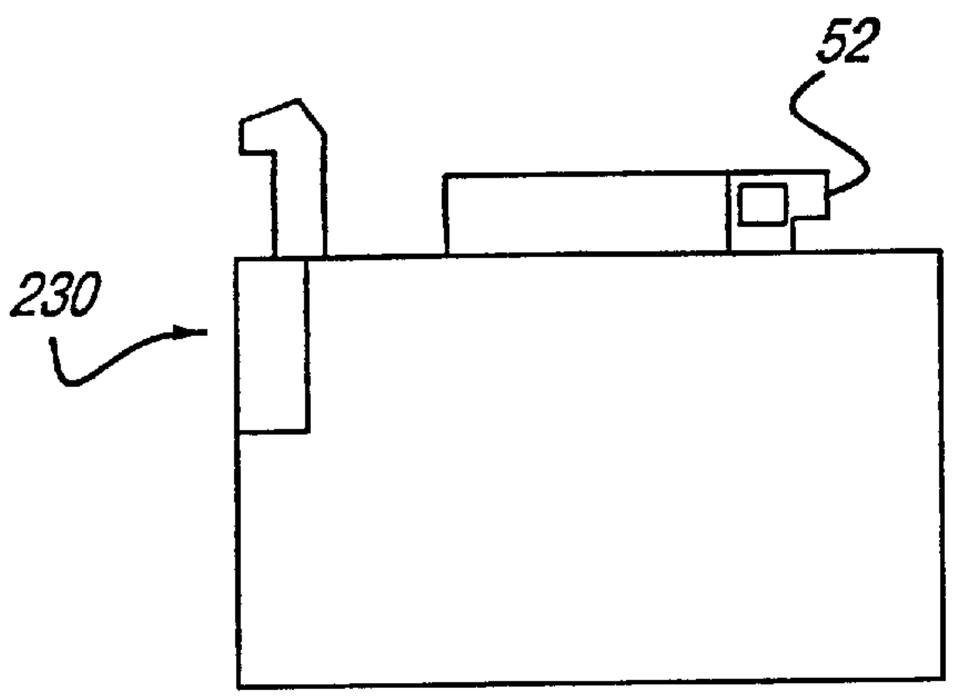


Fig - 21

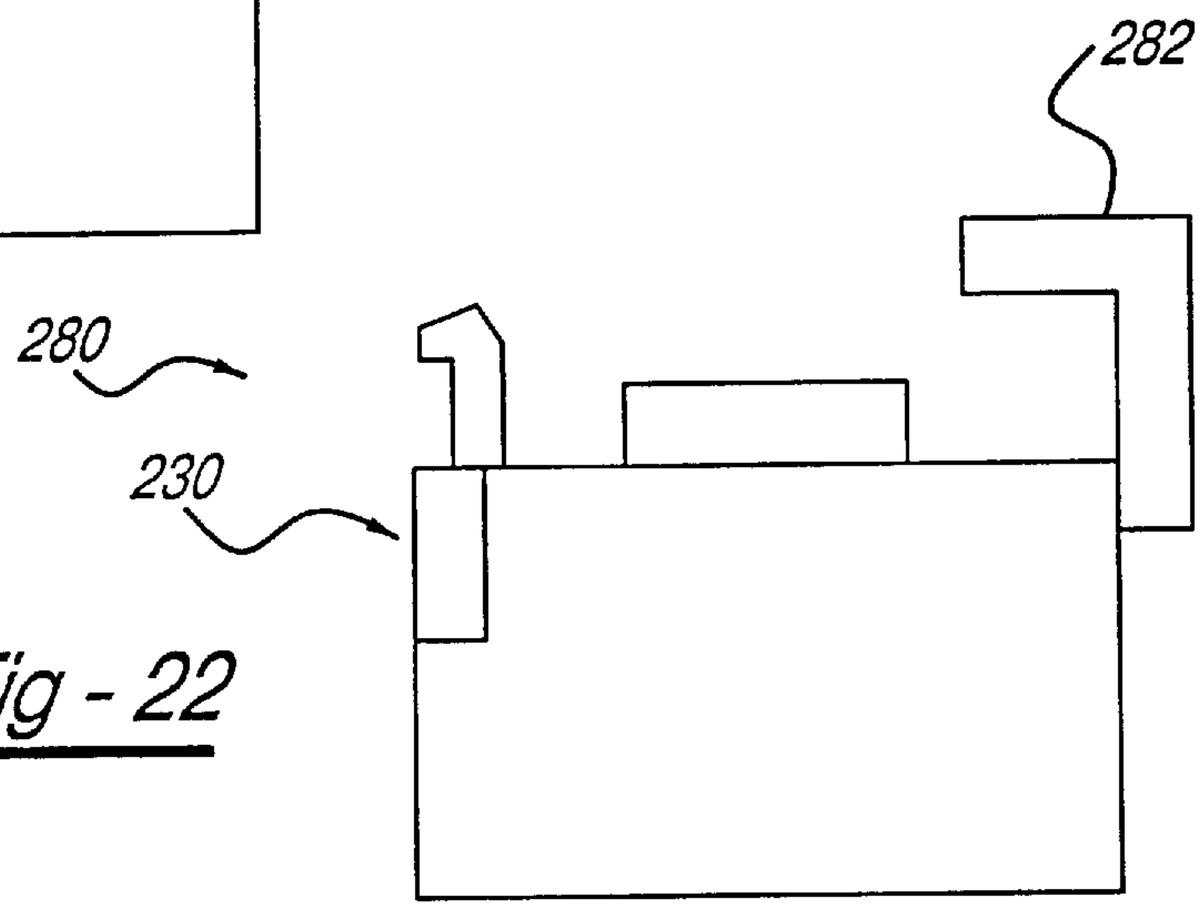


Fig - 22

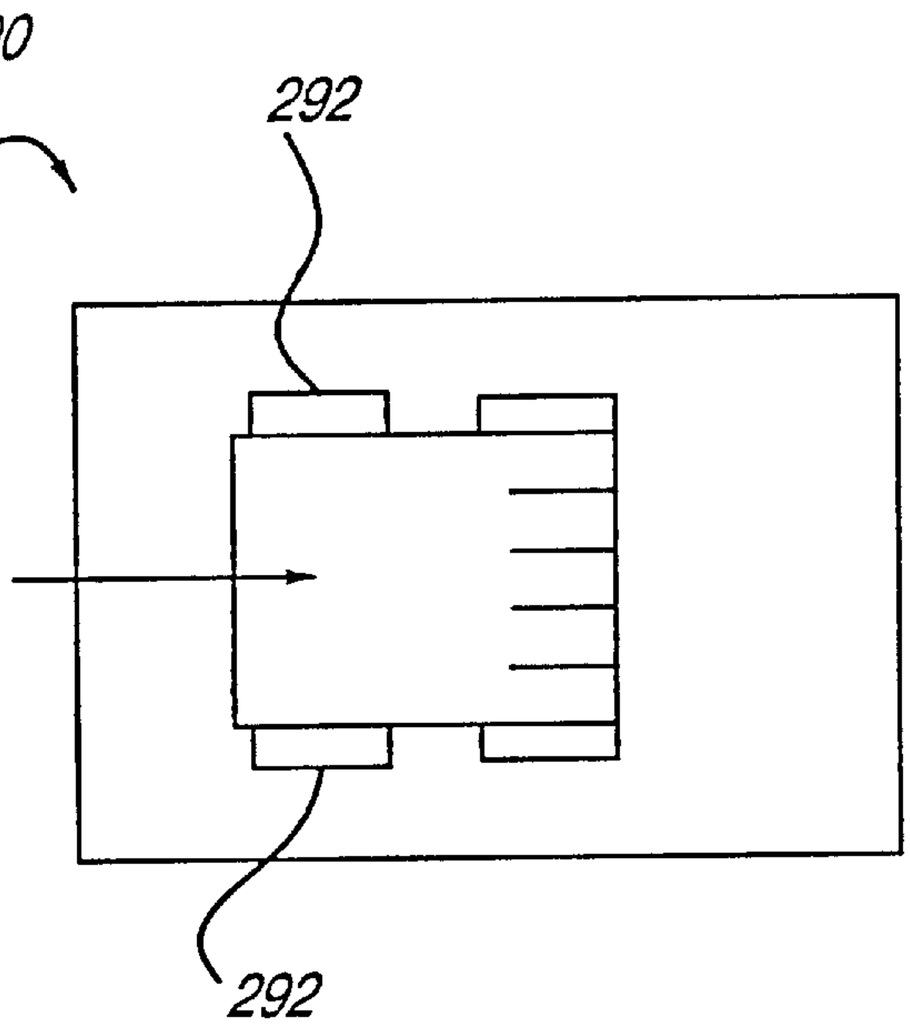


Fig - 23

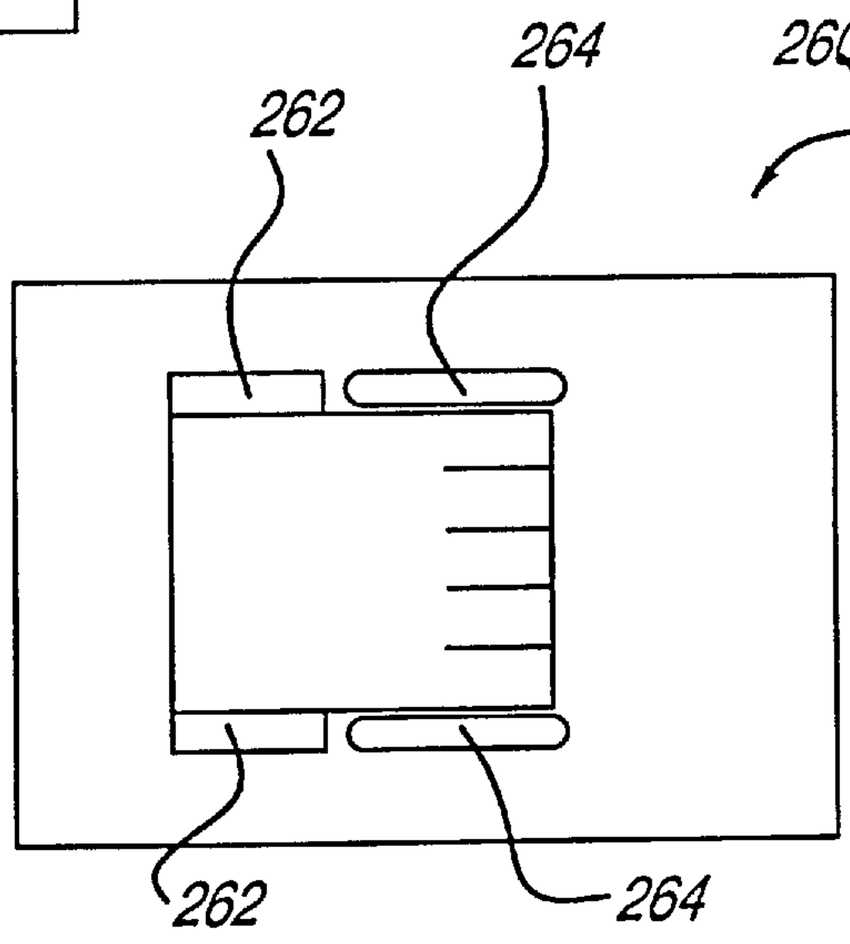


Fig - 20

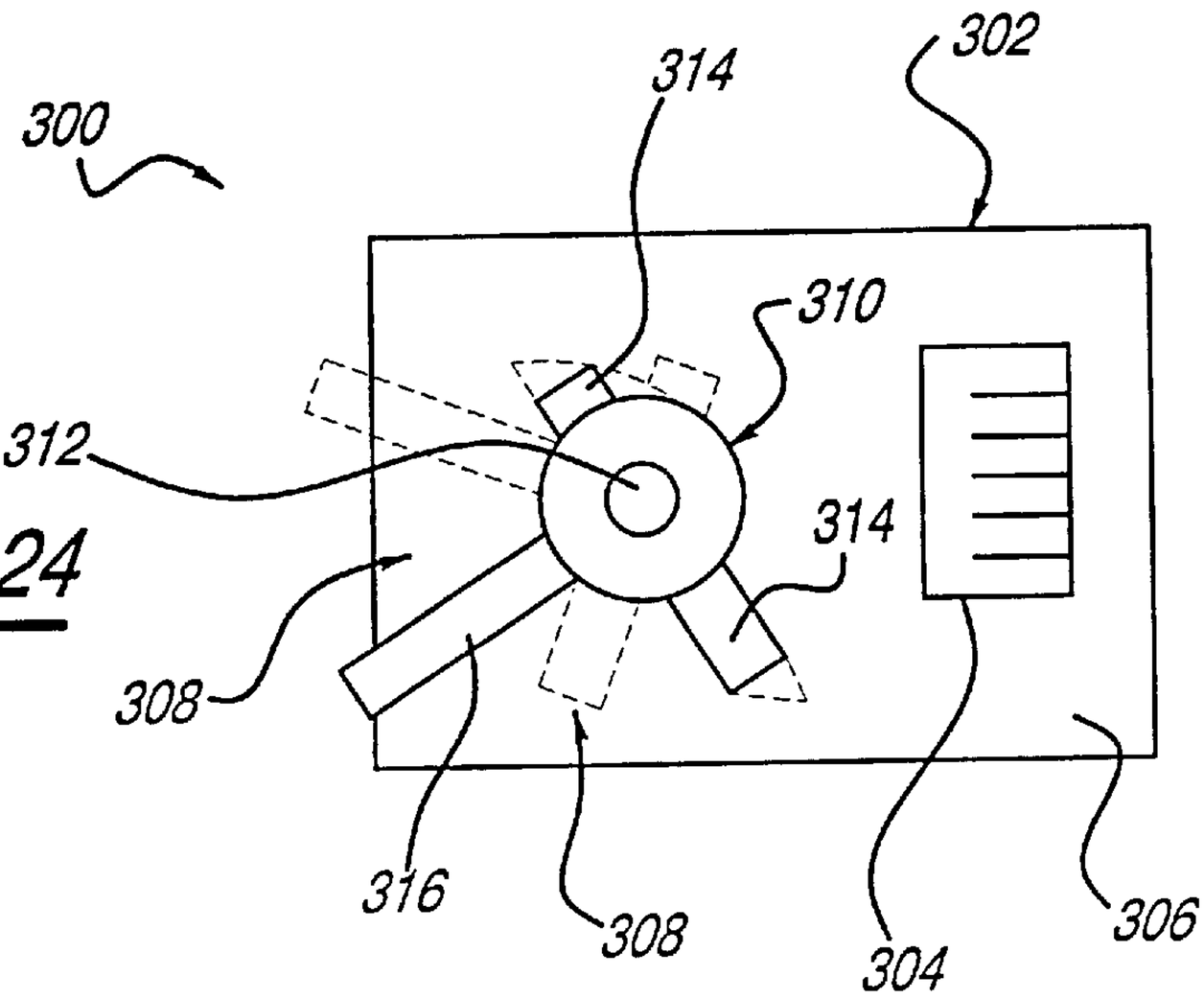


Fig - 24

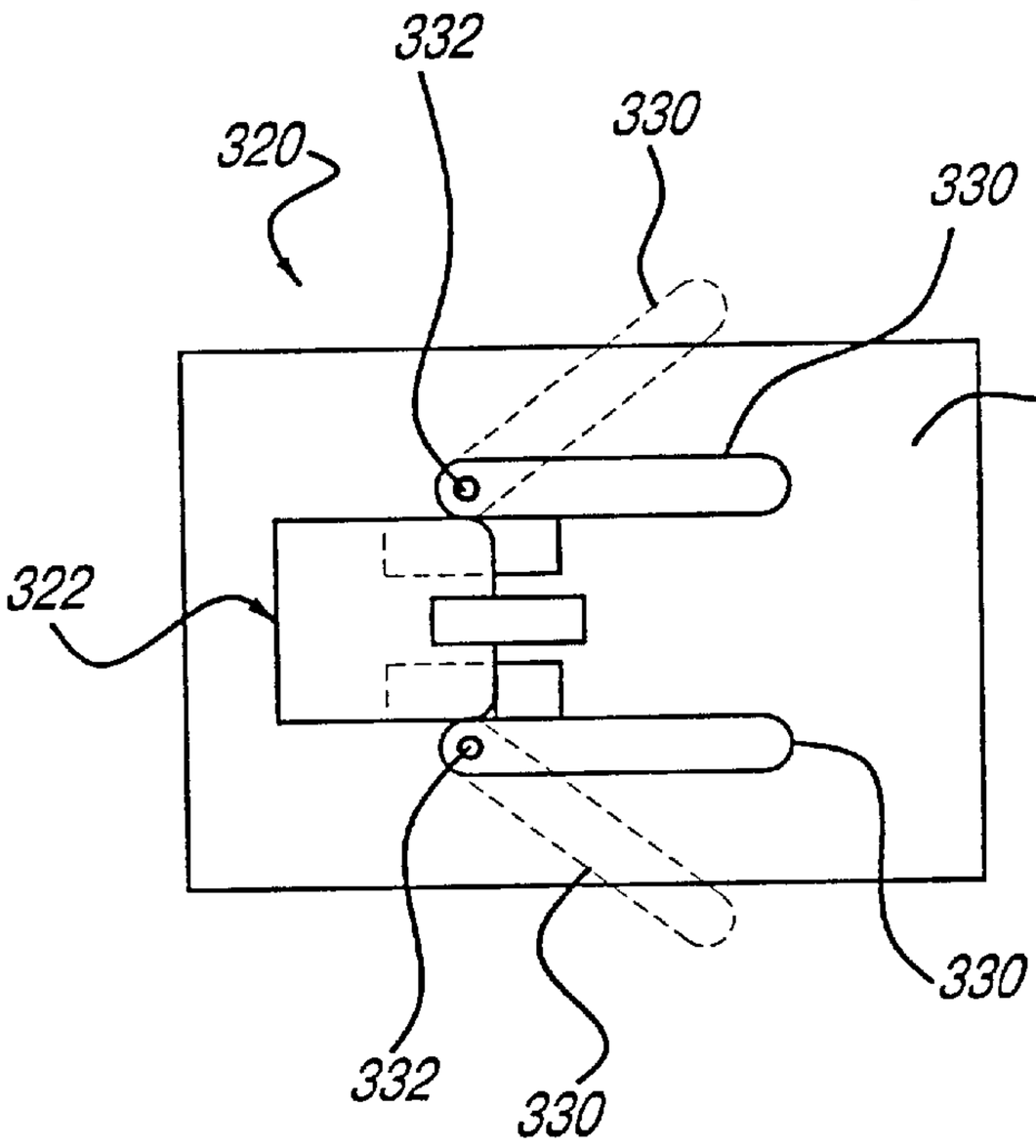


Fig - 25

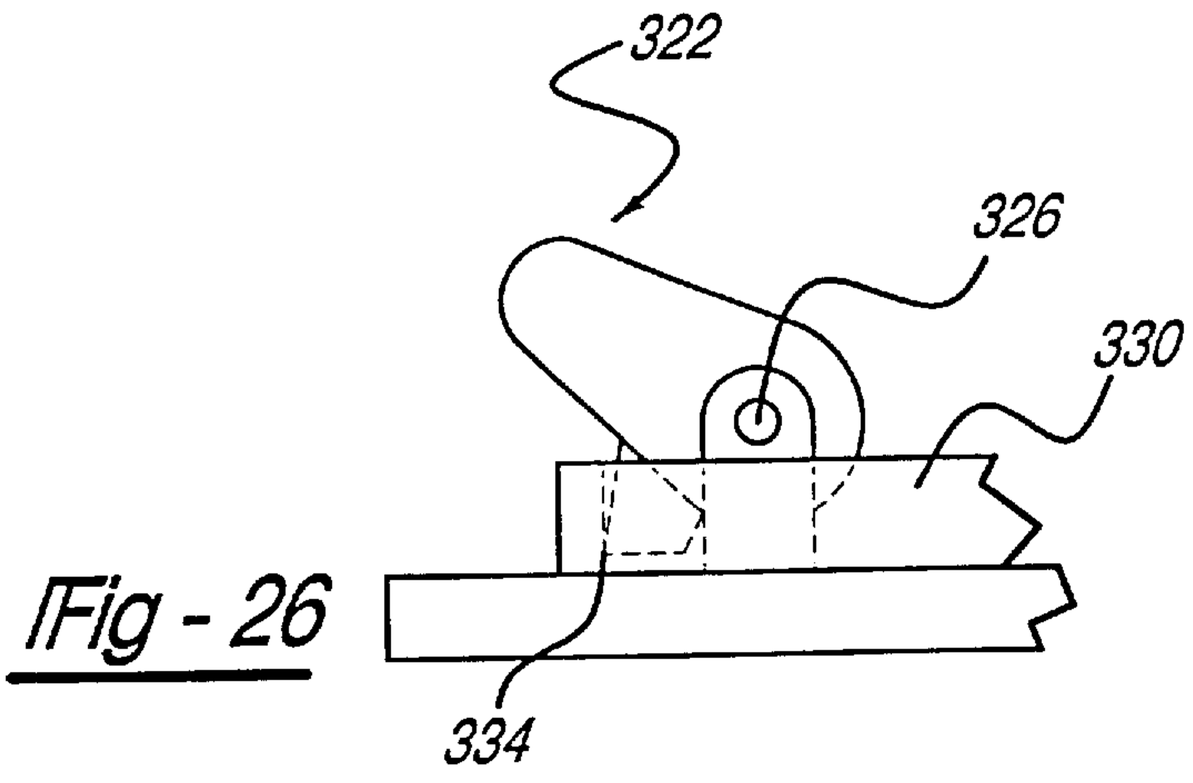


Fig - 26

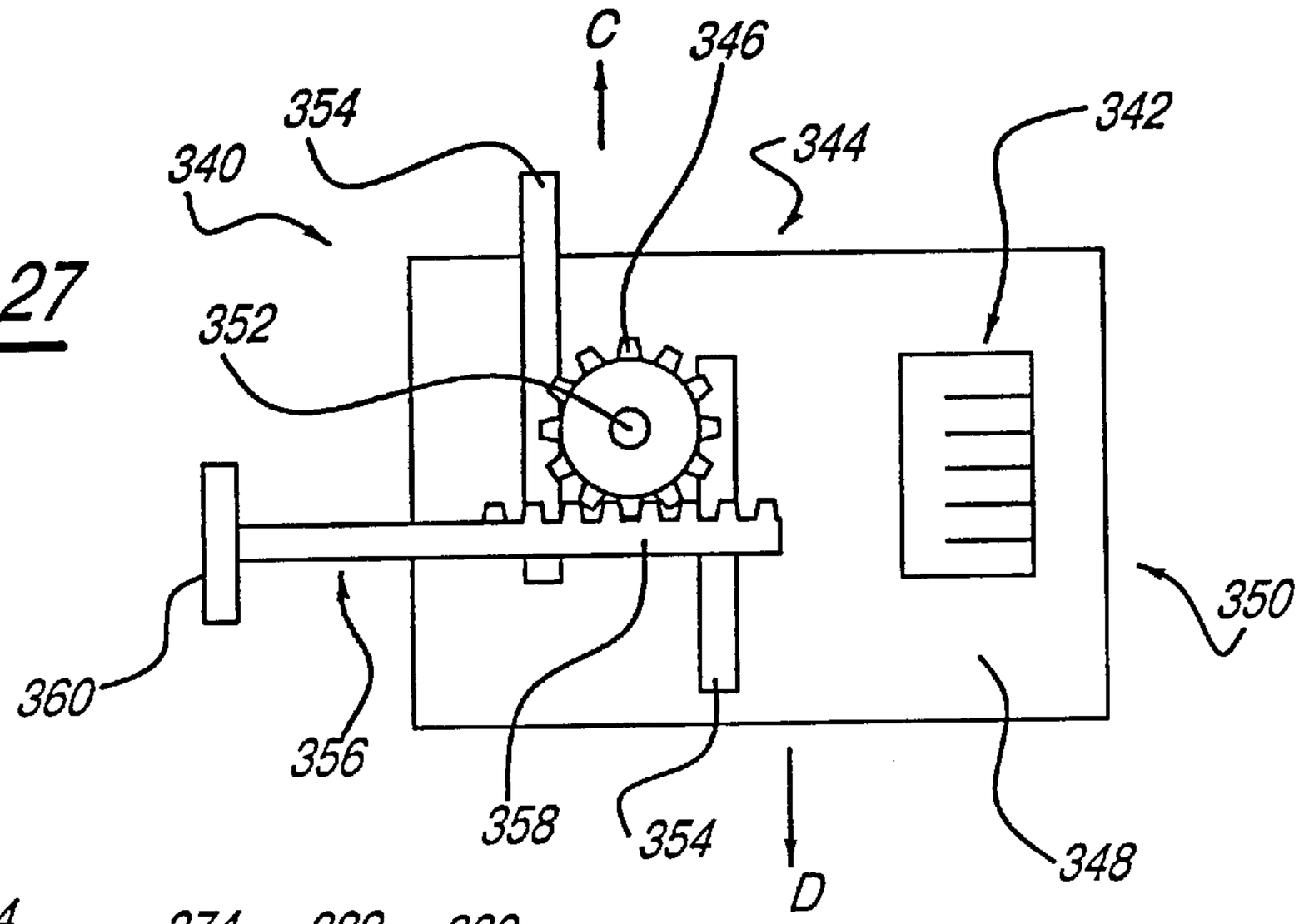


Fig - 27

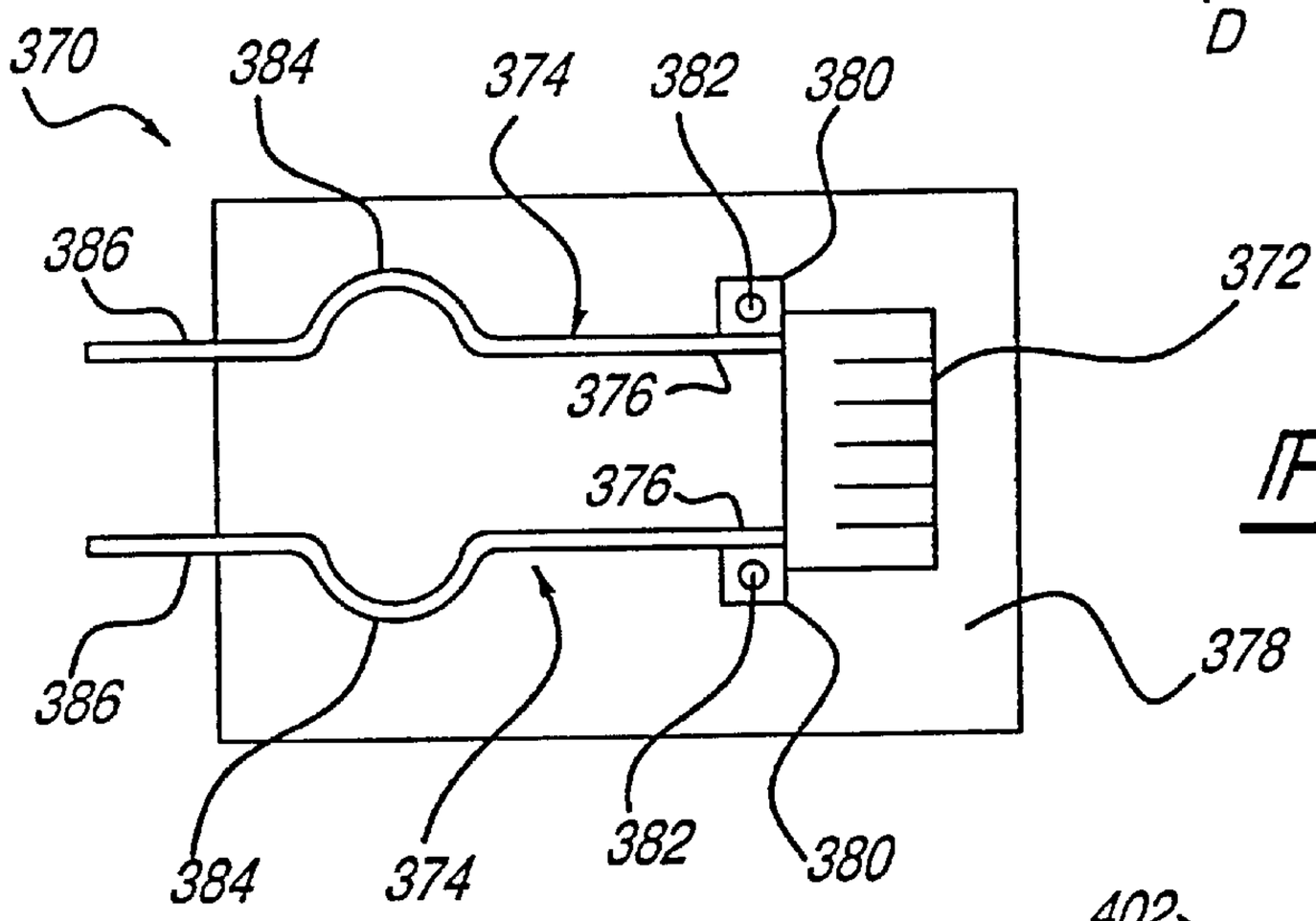


Fig - 28

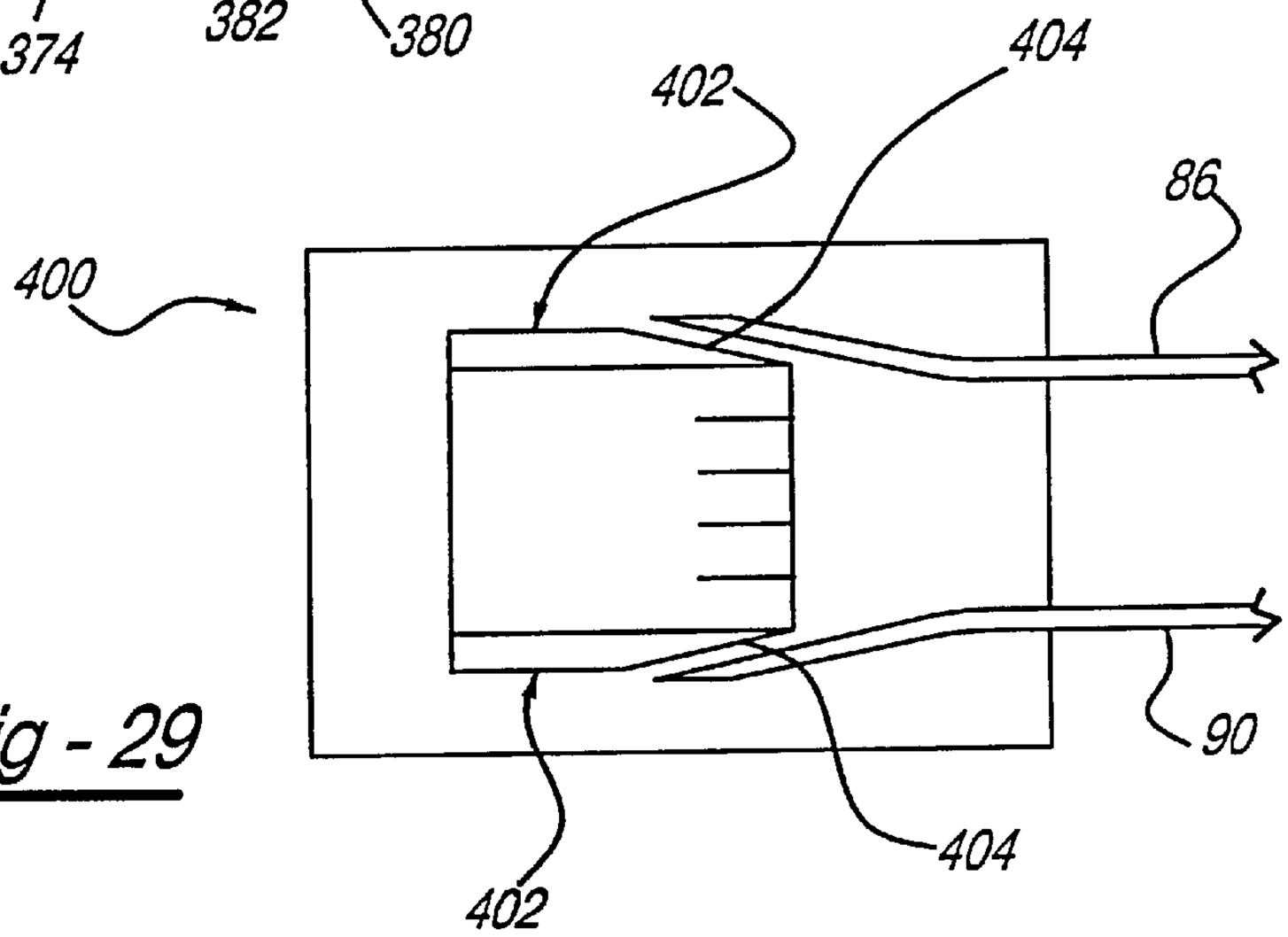


Fig - 29

CORDLESS POWER TOOL SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a continuation of U.S. Ser. No. 09/963,809, filed Sep. 26, 2001, now U.S. Pat. No. 6,515,451 which is a continuation of U.S. Ser. No. 09/732,145, filed Dec. 7, 2000 and issued as U.S. Pat. No. 6,304,058 on Oct. 16, 2001, which is a continuation-in-part of U.S. Ser. No. 09/579,940, filed May 26, 2000 and issued as U.S. Pat. No. 6,329,788 on Dec. 11, 2001, which is a continuation of U.S. Ser. No. 09/133,923, filed Aug. 13, 1998, which is a continuation-in-part of U.S. Ser. No. 09/133,924, filed Aug. 13, 1998 and issued on May 2, 2000 as U.S. Pat. No. 6,057,608.

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention generally pertains to power tools. More particular, the present invention pertains to a system of cordless power tools. More specifically, but without restriction to the particular embodiment and/or use which is shown and described for purposes of illustration, the present invention relates to a system of cordless power tools with an improved battery pack interface. The present invention also pertains to a related method.

Cord less power tools including interchangeable battery units are widely known in the prior art. For example, one such system is shown and described in commonly assigned U.S. Pat. No. 3,952,239. U.S. Pat. No. 3,952,239 discloses a system of tools utilizing individual tool heads, each of which incorporates its own essential elements such as a motor and a blade or chuck. This type of system reduces space requirements for tool storage and increases the life span for each motor. Another significant aspect of systems such as that disclosed by U.S. Pat. No. 3,952,239 is the fact that they permit improved utilization of incorporated nickel-cadmium batteries and an associated battery charger which are particularly high cost elements of the system.

While prior art systems, including but not limited to the type disclosed in U.S. Pat. No. 3,952,239, have proven to be suitable for many intended uses, they are all associated with certain disadvantages and/or limitations.

It is a general object of the present invention to provide an improved system of cordless power tools.

It is another object of the present invention to provide a battery pack for a cordless power tool with first and second housing halves and defining upper and lower chambers. A battery may be located in the lower chamber and a battery pack terminal block may be located in the upper chamber.

It is a related object of the present invention to provide a battery pack for a cordless power tool having longitudinally extending guide rails for engaging the tool and longitudinally extending terminal blades located between the rails. The front tips of the terminal blades and the guide rails have transversely aligned front tips. It is another object of the present invention to provide a battery pack for a cordless power tool having a housing defining an upper chamber receiving a terminal block. The terminal block includes a plurality of pack terminals which are perpendicular to and spaced above a floor of the upper chamber thereby providing improved clearance around the terminals and also reducing the potential for contamination of the terminals with debris.

It is another object of the present invention to provide a method of releasably and electrically interconnecting a battery pack with a tool terminal block of a cordless power tool. The battery pack is first roughly centered along a longitudinal axis of the tool handle through engagement of guide rails with the cooperating rails carried by the tool. Then the battery pack is finely centered through engagement of battery pack terminals through engagement of the tool terminal block with the battery pack.

It is another object of the present invention to provide a battery pack for a cordless power tool which includes suitable protrusions to facilitate manual extraction.

It is another object of the present invention to provide a system of cordless power tools including a rechargeable battery pack, a non-isolated AC/DC converter having recessed terminals for interfacing with the tool and a non-isolated charger having recessed terminals for interfacing with the battery pack.

It is another object of the present invention to provide a system of cordless power tools including a charger having a housing with an open recessed deck for vertically receiving a rechargeable battery pack and a coupling portion for mechanically aligning the battery pack and the charger terminals and also connecting the battery pack mechanically in the charger such that longitudinal translation of the battery pack toward the coupling portion prevents vertical displacement of the battery pack relative to the housing.

Additional benefits and advantages of the present invention will become apparent to those skilled in the art to which this invention relates from a reading of the subsequent description of the preferred embodiment and the appended claims, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1A–1C** are illustrations of a first cordless power tool of a cordless power tool system constructed in accordance with the teachings of a first preferred embodiment of the present invention.

FIG. **2** is an enlarged and exploded perspective view of a first battery pack of the cordless power tool system which is shown in FIG. **1A**.

FIG. **3** is a top view of the battery pack of FIG. **2**.

FIG. **4** is a front view of the battery pack of FIG. **2**.

FIG. **5** is a right side view of the battery pack of FIG. **2**.

FIG. **6A** is an enlarged and exploded perspective view of a tool terminal block carried by the cordless power tool of FIGS. **1A–1C**.

FIG. **6B** is an end view of the main body portion of the tool terminal block.

FIG. **7** is a perspective view of the battery pack terminal block of FIG. **2**.

FIG. **8** is a cross-sectional view illustrating the interface between the battery pack and tool.

FIG. **9** is a right side view of a second battery pack for the cordless power tool system of the present invention.

FIG. **10** is a right side view of a third battery pack of the cordless power tool system of the present invention.

FIG. **11** is a partially exploded and partially cutaway view illustrating a battery pack charger of the system of the present invention shown operatively associated with the first battery pack.

FIG. **12** is a perspective view of a battery pack charger of FIG. **11**.

FIG. **13** is a perspective view of a second cordless power tool of the system of the present invention shown operatively associated with a converter.

FIG. **14** is a cross-sectional view illustrating the interface between the cordless power tool and the converter.

FIG. **15** is a side view of a third cordless power tool of the system of the present invention.

FIG. **16** is a schematic representation illustrating the compatibility of the various batteries and tools of the present invention.

FIG. **17** is a simplified end view of a portion of a cordless power tool constructed in accordance with the teachings of a first alternative embodiment of the present invention.

FIG. **18** is a partially exploded side view of a portion of a cordless power tool constructed in accordance with the teachings of a second alternative embodiment of the present invention shown cut away.

FIG. **19** is a simplified cross-sectional view illustrating the latch of FIG. **18**.

FIG. **20** is a top view of a battery pack of a third alternative embodiment of the present invention.

FIG. **21** is a front side view of a battery pack of a fourth alternative embodiment of the present invention.

FIG. **22** is a front side view of a battery pack of a fifth alternative embodiment of the present invention.

FIG. **23** is a top view of a battery pack of a sixth alternative embodiment of the present invention.

FIG. **24** is a top view of a battery pack of a seventh alternative embodiment of the present invention.

FIG. **25** is a top view of a battery pack of a eighth alternative embodiment of the present invention.

FIG. **26** is a side view of the portion of the battery pack of FIG. **25**.

FIG. **27** is a top view of a battery pack of a ninth alternative embodiment of the present invention.

FIG. **28** is a top view of a battery pack of a tenth alternative embodiment of the present invention.

FIG. **29** is a top view of a battery pack of a eleventh alternative embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

With general reference to the drawings, a system of cordless power tools constructed in accordance with the teachings of a preferred embodiment of the present invention is illustrated. Exemplary cordless power tools of the system are shown to include, by way of examples, a circular power saw **10** (FIG. **1**), a reciprocating saw **12** (FIG. **13**), and a drill **14** (FIG. **15**). The tools **10–14** each include a conventional DC motor (not shown) adapted to be powered with a common voltage. In the exemplary embodiment, the tools **10–14** are intended to be driven by a 24 volt power source. It will become evident to those skilled that the present invention is not limited to the particular types of tools shown in the drawings nor to specific voltages. In this regard, the teachings of the present invention are applicable to virtually any type of power tool and any supply voltage.

With continued reference to the drawings, the system of the present invention is additionally shown to generally include a first battery pack **16**. In the exemplary embodiment illustrated, the battery pack is a rechargeable battery pack **16**. Alternatively, it will be understood that in certain applications the battery pack **16** is a disposable battery.

The system **10** of the present invention is further shown to generally include an AC/DC converter **18** and a battery charger **20** for charging the battery pack **16**. The battery charger **20** is shown in FIG. **11** partially cut-away and

operatively associated with the battery pack **16**. The AC/DC converter is shown in FIG. **13** removably attached to the reciprocating saw **12**. As used herein, the term power source shall include rechargeable and disposable battery packs and an AC/DC converter.

The focus of the present invention most particularly pertains to the interfaces between the tools **10–14** and the battery pack **16**, the interfaces between tools **10–14** and the AC/DC converter **18**, and the interfaces between the battery pack **16** and the battery charger **20**. During the remainder of this detailed description, it will be understood that the tool interface of each of the tools **10–14** is substantially identical.

With particular reference to FIGS. **2–6**, the rechargeable battery pack **16** of the present invention is illustrated to generally include a housing **22**, a battery **24** which in the exemplary embodiment illustrated is a 24 volt nickel-cadmium battery, and a battery pack terminal block **26**. The housing **22** is shown to include first and second clam shell halves **28** and **30** which are joined at a longitudinally extending parting line **32**. Alternatively, it will be understood that the housing **22** may include a pair of halves joined at a laterally extending parting line, or various other constructions including two or more housing portions.

The first and second clam shell halves **28** and **30** of the housing **22** cooperate to form an upper portion **34** defining a first chamber **36** and a lower portion **38** defining a second chamber **40**. The first chamber **36** receives the battery pack terminal block **26**, while the second chamber **40** receives the battery **24**. The battery pack terminal block **26** is fixed against lateral and longitudinal movement relative to the housing **22** except for minimal part tolerance stack up. In one application, the battery pack housing **22** has an overall length of approximately 11.5 cm, an overall width of approximately 9.5 cm, and an overall height of approximately 9.5 cm.

In the exemplary embodiment, the first and second clam shell halves **28** and **30** of the housing **22** are each unitarily constructed from a rigid plastic or other suitable material. The first and second clam shell haves **28** and **30** are joined by thread-forming fasteners **42**. The thread-forming fasteners **42** pass through cooperating apertures **44** and screw boss portions **46** integrally formed with the clam shell halves **28** and **30**. Upon assembly, the fasteners **42** form threads in screw boss portions **46** of housing **30**. In the exemplary embodiment illustrated, the first clam shell half **28** of the housing **22** is formed to include a peripheral groove **50** adapted to receive a mating rib (not specifically shown) peripherally extending about the second clam shell half **30**.

To facilitate releasable attachment of the battery pack **16** to the tool **10**, the upper portion **34** of the housing **22** is formed to include a pair of guide rails **52**. The guide rails **52**, which will be described further below, are slidably received into cooperating grooves **54** defined by rails **55** formed in a housing **56** of the tool **10**. To further facilitate removable attachment of the battery pack **16** to the tool **10**, the upper portion **34** of the housing **22** defines a recess **58**. The recess **58** is adapted to receive one or more latch **59** carried by the housing **56** of the tool **10**. The latch **59** is conventional in construction and operation and is spring biased to a downward position so as to engage the recess **58** upon insertion with the rechargeable battery pack **16**. Removal of the battery pack **16** is thereby prevented until the spring bias of the latch **59** is overcome in a conventional manner insofar as the present invention is concerned.

With continued reference to FIGS. **2–5** and additional reference to FIGS. **7** and **8**, the battery pack terminal block

26 is illustrated to generally include a main body portion **60** constructed of rigid plastic or other suitable material and a plurality of terminals **62**. The terminals **62** are generally planar-shaped blade terminals each oriented in a plane substantially perpendicular to a floor **64** (shown in FIG. **2**) partially defining the upper chamber **36** of the housing **22**. Each blade terminal **62** includes a first end **66** which downwardly extends from the main body portion **60**. The blade terminals **62** each further include a second end **68** which forwardly extends. In the preferred embodiment, the second ends **68** of the blade terminals **62** are upwardly spaced from the floor **64**. As will be appreciated more fully below, such spacing of the blade terminal **62** from the floor **64** provides improved clearance around the blade terminals **62** and reduces the risk of contamination of the terminals **62** with dirt and other debris. In addition, such spacing of the terminals **62** from the floor **64** allows the contacts of the charger **20** to be more fully enclosed by insulating material. This aspect of the present invention will be discussed more further below. Further in the preferred embodiment, the front tips of the blade terminals **62** and the guide rails **52** are transversely aligned.

The main body **60** of the terminal block **26** is shown captured between the clam shell halves **28** and **30** of the housing **22**. This arrangement improves assembly by allowing the terminal block **26** to first be electrically attached to the battery **24** and subsequently captured between the clam shell halves **28** and **30**. The main body **60** is shown to include a pair of arcuate grooves **70** provided in an under surface thereof for accommodating the screw boss portions **46** of the housing **20** upon assembly. Similarly, an upper side of the main body **60** includes a recess **72** for accommodating the recess **58** of the housing **22**. The main body portion **60** is further shown to include a plurality of insulating portions **74** interdisposed between adjacent blade terminal **62** and also positioned outboard of each of the outermost end blade terminals **62**. The insulating portions **74** protect the blade terminals **62** from incidental contact or damage.

In the exemplary embodiment illustrated, the battery pack terminal block **26** includes four blade terminals **62**. Two of the blade terminals **62** are the positive and negative terminals for the battery **24**. A third terminal **62** may be used to monitor temperature of the battery **24** and a fourth terminal may be used for battery identification. The particular functions of the third and fourth blade terminals **62** are beyond the scope of the present invention and need not be described in detail herein. It will be appreciated by those skilled in the art that additional terminals **62** may be employed within the scope of the present invention.

With particular reference now to FIGS. **6**A–B and **8**, a terminal block **76** carried by the tool **10** will be described. The tool terminal block **76** is attached to the housing **56** so as to prevent lateral movement relative to the housing except for part tolerance stack up. In the exemplary embodiment illustrated, the tool terminal block **76** is attached to the housing **56** so as to also prevent longitudinal movement. However, as discussed below, certain applications may desire limited longitudinal translation of the tool terminal block **76**.

The tool terminal block **76** is illustrated to generally include a main body portion **80**, a first or negative terminal member **82**, and a second or positive terminal member **84**. The first terminal member **82** includes a negative male terminal **86** and a negative female terminal **88**. Similarly, the second terminal member includes a positive male terminal **90** and a positive female terminal **92**. As will be further discussed below, the female terminals **88** and **92** are adapted to receive the positive and negative blade terminals **62** of the battery pack terminal block **26**. The male terminals **86** and **90** are adapted to electrically attach the tool **10** to the converter **18**. As shown in FIG. **8**, when the battery pack **16** is operatively attached to the tool **10**, the male terminals **86** and **90** of the tool terminal block **76** are received within clearances, shown in the exemplary embodiment as apertures **96**, provided in each of the rails **52**. Alternatively, the clearances **96** to accommodate the male terminals **86** and **90** may be in the form of grooves provided in the rails **52** or the rails may be reduced in length.

In applications where the battery pack **16** is disposable, the male terminals **86** and **90** may be cut off. In such applications, the rails **52** need not be configured to accommodate the male terminals **86** and **90**. It will be understood that the male terminals **86** and **90** serve no electrical function when the battery pack **16** is attached to the tool **10**.

In one particular aspect of the present invention, a method of using a cordless power tool includes a first general step of providing a cordless power tool having a housing **22**. The housing **22** preferably defines a pair of lateral grooves **54**. The tool includes a first tool terminal block **76** having a pair of male terminals **86** and **90** and a pair of female terminals **88** and **92**. As discussed above, the male terminals **86** and **90** are intended to electrically couple to a converter **18**. In a second general step, the method of the present invention includes cutting off at least one of the male terminals **86** and **90**. In this manner, the tool may accomodate a rechargeable battery pack without the necessary clearances for the male terminals **86** and **90**.

As shown particularly in the end view of FIG. **6**B and the cross-sectional view of FIG. **8**, the main body **80** of the tool terminal block **76** includes a plurality of window frames **98** which each define a window or opening **100** for receiving and guiding one of the blade terminals **62**. The female terminals **88** and **92** of the tool terminal block **76** are disposed within adjacent ones of the window frames **98**. The window frames **98** are generally U-shaped and each include a pair of longitudinally extending legs **102** connected by an intermediate segment **103**. Openings **104** are provided between adjacent window frames **98** for receiving the insulating portions **74**. In the exemplary embodiment, the ends of each of the legs **102** of the frames **98** are generally triangular in shape so as to define lead-in surfaces for the insulating portions **74** into the openings **104** and also for the terminal blades **62** into their respective opening **100**.

As shown most clearly in FIG. **6**B, the main body portion **80** of the tool terminal block **76** includes a pair of laterally spaced rails **97**. The main body portion **80** further includes a pair of apertures **101** which receive the male terminals **86** and **90**. The rails **97** are adapted to be received within grooves **99** provided in the housing **30** of the battery pack **16** immediately below the guide rails **52**. As will be further discussed below, the laterally spaced rails **97** establish a tight fit with the grooves **99** for precisely aligning the tool terminal block **76** with the battery pack terminal block **26**.

With specific reference to FIG. **11**, a partially cutaway view of the battery charger **20** of the system of the present invention is shown operatively associated with a battery pack **16** partially removed for purposes of illustration. FIG. **12** is an elevated perspective view of the charger **20** shown with the battery pack **16** removed. In the preferred embodiment, the battery charger **20** is a non-isolated charger. As used herein, the term non-isolated will be understood to mean that the output voltage is not isolated from the mains input voltage. The battery charger **20**

includes a housing **110** including an open recessed deck **111**. The battery charger housing **110** further includes a rear coupling section **112** for mechanically engaging the upper portion **34** of the battery pack housing **22**.

The rear coupling section **112** includes a pair of opposed grooves **54** similar to that provided in the tool housing **56** which receive the guide rails **52** of the battery pack **22**. The battery charger **20** further includes a set of female terminals having at least a pair of female terminals **114** for receiving the positive and negative blade terminals **62** of the battery terminal pack **26**. An electrical cord **116** provides AC electricity (for example, 120 volt electricity) to the battery charger **20**. Adjacent positioning of the positive and negative terminal blades **62** permits a circuit layout of the charger which reduces electromagnetic interference.

The battery charger housing **110** is shown most clearly in FIG. **12** to define a plurality of blade terminal openings **140** corresponding in number to the blade terminals **62** of the battery pack **16**. The blade terminal openings **140** are defined by insulating portions **142** adapted to cooperatively receive the insulating portions **74** of the battery pack **16**. In this regard, adjacent insulating portions **142** are spaced apart to define openings **144** for receiving the insulating portions **74**. The insulating portions **142** of the charger housing **110** each include a pair of vertically oriented sidewalls **146** and a horizontally oriented upper segment **148**. The upper segments **148** function to conceal the terminals **114** from incidental contact or damage. Since the blade terminals **62** of the battery pack **16** are vertically spaced from the floor **64**, the upper segments **148** can be accommodated therebetween. It will be understood by those skilled in the art that the remainder of the battery charger **20** is conventional in construction insofar as the present invention is concerned.

The battery pack **16** is loaded into the charger **20** by first vertically positioning the pack **16** on the deck **111** and then sliding the pack **16** rearward to engage the rails **52** of the pack **16** with the grooves **54** of the charger **20**. While on the deck **111**, the pack **16** is supported by ribs **113**. The open deck **111** facilitates location of the pack **16** in the charger **20** since the pack **16** is first grossly aligned with the charger **20** through placement on the deck **111** and then mechanically and electrically connected through a rearward sliding action. A mechanical interface of improved stability is provided. In the event a user lifts the pack **16** and charger **20** by gripping the pack **16** only, the engaged rails **52** and grooves **54** avoid potentially damaging loads on the electrical terminals. Thus, the combination of the loading deck **111** and the rear coupling section **112** provides improved loading ergonomics and mechanical stability of the connection.

Turning now to FIG. **13**, the converter **18** of the system of the present invention is illustrated operatively attached to the reciprocating saw **12**. Again, it will be appreciated by that the particular tool **12** shown in FIG. **12** is merely exemplary. In this regard, the converter **18** is operative for use with the circular saw **10** shown in FIG. **1**, the drill **14** shown in FIG. **15**, or any other tool similar constructed in accordance with the teachings of the present invention. The converter **18** of FIG. **13** is specifically adapted for converting main voltage AC electricity to 24 volt DC electricity.

In the preferred embodiment, the converter **18** is a non-isolated converter and includes a housing **120** and an electrical power cord **122**. The housing **120** is substantially similar to the housing **22** of the battery pack **16**. In this regard, the housing **120** includes first and second clam shell halves joined at a longitudinally extending parting line. Alternatively, the housing **120** may include three (3) or more pieces. An upper portion **122** of the housing **120** includes a pair of guide rails **124** similar to those of the battery pack **16**.

With continued reference to FIG. **13** and additional reference to FIG. **14**, the converter **18** is shown to include a pair of female terminals **128** adapted to receive the male terminals **86** and **90** of the tool terminal block **76**. The female terminals **128** are recessed within the upper portion **122** of the housing **120** of the converter **18**. In the preferred embodiment, the female terminals **128** are recessed within the housing **120** of the converter **18** approximately 8 mm or more. AC power is converted to DC power by the converter **18** and delivered to the tool **12** through the terminals **128**. When the converter **18** is operatively installed on the tool **12**, the female terminals **88** and **92** of the tool terminal block **76** are electrically inoperative.

As discussed above, the exemplary tools **10–14** shown throughout the drawings are specifically designed to operate on 24 volt DC electricity. With reference to the schematic illustration of FIG. **16**, the system of the present invention is shown to further include second and third lines B and C of cordless power tools specifically intended for operation at alternate voltages. With the exception of their motors, the second and third lines B and C of power tools are substantially identical to the tools **10–14** of the first line A. For purposes of identification, the tools of the second and third lines B and C are denoted in the drawings with common reference numerals which are primed and double-primed, respectively. It will be understood that the tools **10'–14'** and **10"–14"** are powered by second and third voltages, respectively. In the exemplary embodiment, the second and third voltages are lower and higher than the first voltage, respectively. The multiple lines A–C of tools operatively driven by different voltage values provide a consumer with a wide range of selection to accommodate particular power requirements.

As shown in FIGS. **9** and **10**, the system of the present invention is illustrated to include second and third battery packs **16'** and **16"** for providing electricity at the second and third voltages, respectively. The second and third battery packs **16'** and **16"** are substantially identical in construction to the first battery pack **16**. For this reason, reference numerals introduced above with respect to the first battery pack **16** will be used to identify common elements of the second and third battery packs **16'** and **16"**.

The third battery pack **16"** differs from the first battery pack **16** in that its housing **22** is substantially longer in a longitudinal direction so as to accommodate additional battery cells. In the exemplary embodiment, the width and height dimensions of the third battery pack **16"** are identical to corresponding dimensions of the first battery pack **16**. The rails **52** of the third battery pack **16"** are correspondingly longer as are the grooves **54** formed in the housings **56** of the tools **10"–14"** of the third line.

The system of the present invention is intended to prevent operative engagement of any battery pack (e.g., **16** or **16"**) with a lower voltage value tool so as to protect the electric motors from damage. For example, the higher voltage third battery pack **16"** is intended to be locked out of both the tools **10–14** of the first line A and the tools **10'–14'** of the second line B. In this regard, the housing **22** of the third battery pack **16"** is shown to include a lock-out rib **130**. In the embodiment illustrated, the rib **130** extends approximately 86 millimeters from a datum wall **132** and is approximately two millimeters in height and two millimeters in width. The datum wall **132** normally limits translation of the rails **52** relative to the grooves **54**. An appropriate stop

surface **133** will engage the rib **130** and prevent engagement of the third battery pack **16**" which has a higher voltage with the terminal blocks **76** of the tools of the first and second lines A and B.

With particular reference to FIG. **5**, the first battery pack **16** is designed to be locked out of the lower voltage tools **10'–14'** of the second line B and will not be long enough to engage the terminal block of the third line C. The first battery pack **16** has a lockout rib **134** which extends approximately **14** millimeters from the datum wall **132**. Again, the lockout rib **134** is approximately two millimeters in height and two millimeters in width. While not specifically shown, it will be understood that the grooves **54** of the tools **10–14** of the first line A are formed to accept the lockout rib **134** while the grooves of the tools of the lower voltage second line B are not.

With specific reference to FIG. **9** illustrating the second battery pack **16'**, it will be understood that the second battery pack **16'** is not specifically intended to be mechanically locked out of any of the tools of any of the lines A–C. However, the length of the battery pack **16'**, which in the preferred embodiment is identical to that of the first battery pack **16**, is insufficient to engage the tool terminal block of the third line C of tools. The battery pack **16'** is adapted to work in both the first and second tools lines A and B. In the alternative arrangement discussed above in which the higher voltage third battery pack **16**" has a length identical to that of the first and second battery packs **16** and **16'**, the low voltage second battery pack **16'** would not need to be locked out of the tools of the higher voltage tool line C. However, sufficient power may not be available for intended usages. The dashed line between the battery packs **16** and **16'** and the tools of the third line C shown in FIG. **16** indicates this alternative where electrical engagement is not prevented.

Attachment of the battery pack **16** to the housing **56** automatically aligns or centers the blade terminals **62** of the battery pack **16** with the female terminals **88** and **92** of the tool terminal block **76**. When the battery pack **16** is inserted into the tool housing **56** the alignment of pack terminal blades **62** and the female tool terminals **88** and **92** occurs in two stages. In a first stage, the guide rails **52** are loosely engaged in the mating tool grooves **54**. The total travel of the battery pack **16** relative to the housing **56** is approximately 60 mm. In the second stage, which occurs during approximately the last 22 mm of travel of the pack **16** relative to the housing **56**, the grooves **99** in the housing **30** of the battery pack **16** engage the rails **97** of the tool terminal block **76** in a tight fit. In the preferred embodiment, the housing **30** and the alignment rails **97** are in a snug fit. This engagement precisely aligns the battery pack **16** with the tool terminal block **76** and in turn aligns the pack terminal block **26** with the tool terminal block **76**. Normally, the blade terminals **62** of the pack **16** will engage the female tool terminals **88** and **92** without further alignment. If the terminal blades **62** are bent, then the terminal blade **62** may engage an associated window frame **98** of the tool terminal block **76**. The tapered legs **102** of the frame **98** may aid in straightening a slightly bent terminal blade **62**. If the terminal blade **62** is severely bent, entry of the terminal blade **62** into the opening **100** is prevented by the frame **98**.

As noted above, it may be alternatively desirable to permit the tool terminal block **76** to longitudinally slide in the tool housing **56**. When the pack terminal blades **62** are inserted in the female tool terminals **88** and **92** in such an arrangement, the pack terminal blades **62** engage the female tool terminals **88** and **92** and slightly translate the tool terminal block **76** rearwardly. For example, such translation may be on the order of approximately 2 mm. When the tool terminal block **76** reaches its limit of travel relative to the tool housing **56**, the pack terminals blades **62** are inserted between the female tool terminals **88** and **92**. Then, the pack blade terminals **62** are firmly gripped between the female tool terminals **88** and **92**. If the battery pack **16** moves relative to the tool housing **56** due to vibration of the tool **10** along an axis parallel to the guide rails **52**, the pack **16** and the tool terminal block **76** move together. This conjoint movement of the tool terminal block **76** and the pack **16** may reduce wear on the pack terminal blades **62** and female tool terminals **88** and **92**.

With particular reference to FIG. **2**, the battery pack **16** of the present invention is shown to include protrusions **160** to facilitate extraction of the battery pack **16** from the tool housing **56** or from the charger **20**. In the exemplary embodiment, each of the housing halves **28** and **30** includes a pair of vertically spaced protrusions **160** disposed on a lateral side of the housing **22** adjacent a rear side of the housing **22**. Each protrusion **160** is illustrated to be convexly curved and have a forward portion which the user may directly engage with a thumb or index finger. For example, the width of the battery pack **16** permits the user to engage an upper protrusion **160** of the second housing half **30** with the right thumb and an upper protrusion **160** of the first housing half **28** with the right index finger. The lower protrusions **160** may be used in a substantially similar manner when the battery pack **16** is inverted in the charger **20**.

Referring generally to FIGS. **17** through **26**, various alternative embodiments of the present invention will be described. With particular reference to FIG. **17**, a simplified rear end of a portion of a power tool **200** constructed in accordance with the teachings of a first alternative embodiment of the present invention is illustrated. As with the tools of the system **10** of the preferred embodiment of the present invention, the tool **200** includes a rechargeable battery pack **202** having a battery pack terminal block **204**. The battery pack terminal block **204**, which is substantially identical to battery pack terminal block **26** described above, interfaces with a tool terminal block (not specifically shown) substantially identical to tool terminal block **76** described above. The rechargeable battery pack is formed to include a pair of inwardly extending rails **206** which slidably engage a corresponding pair of engagement portions **207** of a housing **208** of the tool **200**. In the embodiment illustrated, the engagement portions **207** are outwardly stepped portions of the housing **208**.

With particular reference to the simplified and partially exploded view of FIG. **18** and the cross-sectional view of FIG. **19**, a tool **220** constructed in accordance with a second alternative embodiment of the present invention is illustrated. In this embodiment, the tool **220** includes a rechargeable battery pack **222** which does not slide into a housing of the tool **224** in the manner discussed with the tools of the system **10** described above, but rather engages the housing **224** in the direction of arrow A. The rechargeable battery pack **222** carries at least one terminal **226** which engages a corresponding number of terminals **228** carried by the housing **224**. In one application, the terminal **226** carried by the rechargeable battery **222** is a male terminal and the terminal **228** carried by the housing **224** is a female terminal.

The rechargeable battery pack **222** includes a pair of latch mechanisms **230**, one of which is illustrated in FIGS. **18** and **19**. It will be understood that a substantially identical latch mechanism **230** is incorporated on the opposing lateral side of the rechargeable battery pack **222** which is not shown.

The latch mechanism **230** includes a button portion **232** which extends through an opening **234** defined in a housing **236** of the rechargeable battery pack **222**. In one application, the latching mechanism **230** is unitarily constructed of plastic or other suitable material and is connected to a lower portion of the housing **236** through a cantilevered portion **238**. An upper portion **240** of the latching mechanism **230** includes an outwardly extending flange **242** which engages a longitudinally extending groove **244** formed in the housing **224** in a manner substantially described above with respect to the tools of the system **10**. A spring member **246** biases the latching mechanism **230** outward in the direction of arrow B. As most particularly shown in FIG. **19**, an upper end **248** of the spring **246** engages the latching mechanism **230** and a lower end **250** is interconnected to a lower portion of the housing **236** of the rechargeable battery pack **232** in any conventional manner.

In operation, the buttons **232** of the latching mechanisms **230** are simultaneously inwardly depressed against the bias of the springs **246** such that the rechargeable battery pack **222** can be attached to or removed from the housing **224**. While not illustrated, it will be understood by those skilled in the art that the latching mechanism **230** may incorporate appropriate lead-in surfaces such that advancement of the rechargeable battery pack **222** in the direction of arrow A inwardly forces the latching mechanisms **230** against the bias of the springs **246**.

With particular reference to FIG. **20**, a top view of a rechargeable battery pack **260** for use with a third alternative embodiment of the present invention is illustrated. While not illustrated in great detail, it will be understood that the rechargeable battery pack **260** includes a pair of laterally spaced guide rails **262** which are shorter but otherwise similar in construction to the guide rails **52** discussed above. As with the embodiment described above, the guide rails **262** are slidably received into cooperating grooves **54** defined by rails **55** formed in a housing **56** of the tool **10**. Distinct from the embodiment discussed above, the rechargeable battery pack **260** includes a pair of female terminals **264** which cooperate with the male terminals **86** and **90** of the tool terminal block **76**. The female terminals **264** are each aligned with one of the grooves defined by the laterally spaced guide rails **262**.

With particular reference to the simplified front side view of FIG. **21**, a rechargeable battery pack **270** for use with a fourth alternative embodiment of the present invention in illustrated. The rechargeable battery pack **270** is similar to the rechargeable battery pack of the second alternative embodiment discussed above. However, the rechargeable battery pack **270** includes a single latching mechanism **230**. On the side opposite the latching mechanism **230**, the rechargeable battery pack **270** includes a longitudinally extending rail **52** substantially identical to the similarly identified element described above. A portion of a tool housing is shown in hidden lines and includes inwardly extending rails **274** and **276**.

With particular reference to FIG. **22**, a front view similar to FIG. **21** of a rechargeable battery pack **280** for use with a fifth alternative embodiment of the present invention is shown. Again, the battery pack **280** includes a single latching mechanism **230** substantially identical to that discussed above. In this embodiment, on the opposite side of the latching mechanism **230**, the rechargeable battery pack **280** is illustrated to include a rail **282** which cooperates with the housing **284** (shown in hidden lines) of the tool in a manner substantially discussed above with respect to the tool **200** of FIG. **17**.

With particular reference to FIG. **23**, a top view of a rechargeable battery pack **290** for use in a sixth alternative embodiment of the present invention is illustrated. The battery pack **290** is intended to cooperate with the tools of the system **10** described above. In this embodiment, the rechargeable battery pack includes a pair of longitudinally extending rails **292** which are substantially identical, albeit shorter, in construction to the rails described above and referenced at number **52**. The shortened length of the rails accommodates the male terminals **86** and **90**, where present.

With particular reference now to FIG. **24**, a top view of a rechargeable battery pack **300** is illustrated for use in a seventh alternative embodiment of the present invention. The rechargeable battery pack includes a housing **302** which is similar in construction to the housing **22** described above with respect to the system **10** of the present invention and is adapted to cooperatively engage the tools of the system **10**. A battery pack terminal block **304** upwardly extends from an upper surface **306** of the housing **302** and engages the tool terminal block **80**. In this embodiment, the rechargeable battery pack **300** does not include longitudinal rails such as those identified above at reference numeral **52**, but rather includes a locking mechanism **308** for engaging the grooves **54** defined by the rails **55**. The locking mechanism **308** includes a rotatable member **310** mounted to the top **306** of the housing **302** for rotation about a vertically extending pivot axis **312**. The rotatable member **310** is illustrated to include a pair of rail locking protrusions **314** positioned on an opposite side of the pivot axis **312**. The rotatable member **310** further includes a manually operated handle **316**.

The locking mechanism **308** is rotatable between an unlocked position in which the rechargeable battery pack **300** can be moved relative to the housing and a locked position in which the rail locking protrusions **314** engage the grooves **55**. The unlocked position is shown in solid lines in FIG. **24**. The locked position is shown in hidden lines. It will be understood that the locking protrusions **314** may be formed to include camming portions at their distal ends (shown in phantom) so as to increase the locking force applied to the grooves **55**.

With particular reference to FIGS. **25** and **26**, a portion of a battery pack **320** form use with an eighth alternative embodiment of the present invention is illustrated. In this embodiment, a tab **322** is rotatably attached to a housing **324** of the rechargeable battery pack **320** for rotation about a pivot axis **326**. A pair of locking portions **330** are pivotally interconnected to the housing **324** for rotation about vertically extending pivots **332**. The tab **322** includes a camming portion **334** that on rotation pushes the locking portions **330** from unlocked position to locked positions. The unlocked positions are shown in solid lines. The locked positions are shown in hidden lines. In the locked positions, the locking portions **330** engage the grooves **55** of the tools of the system **10**. In operation, as the rechargeable battery pack **320** is inserted into the housing of the power tool, the power tool housing forces the tab **322** to rotate downwardly (as shown in FIG. **26**), thereby locking the rechargeable battery pack **320** to the housing.

With particular reference to FIG. **27**, a top view of a rechargeable battery **340** for use with a ninth alternative embodiment of the present invention is illustrated. As with the rechargeable battery pack **16** as described above, the rechargeable battery pack includes a terminal block **342** which engages a tool terminal block of a tool. The rechargeable battery pack **340** includes a locking arrangement for **344** for releasably engaging the grooves **55** of the tools of the system **10**. A pinion gear **346** is attached to a top surface

348 of a housing 350 of the rechargeable battery pack 340. The pinion gear 346 is rotatable about a vertically extending axis 352. The pinion gear 346 meshingly engages a pair of rack members 354. The locking arrangement 344 further includes a rod 356 with a first end 358 meshingly engaging the pinion gear and a second end including a manually rotatable handle member 360. Rotation of the handle member 360 in a first direction causes rotation of the pinion gear 346 in a clockwise direction (as shown in FIG. 27) which in turn causes a rear one of the rack members to move in the direction of arrow C and a forward one of the rack members 354 to move in direction of arrow D. In this manner, the distal ends of the rack members 354 engage the grooves 55 and thereby lock the rechargeable battery pack 340 to the housing of the tool. Conversely, rotation of the handle member 360 in the opposite direction causes counterclockwise rotation of the pinion gear 346 and resultantly draws the rack members 354 inwardly to thereby release the rechargeable battery pack 340 from the housing of the tool.

With particular reference to FIG. 28, a top view of a battery pack 370 for use in a tenth alternative embodiment of the present invention is illustrated. In this embodiment, the rechargeable battery pack 370 is again intended to engage the housings of the tools of the system 10. The rechargeable battery pack 370 includes a battery pack terminal block 372 which engages the tool terminal block. The rechargeable battery pack 370 further includes a pair of locking members 374 for engaging the grooves 55 of the tools of the system 10. In the embodiment illustrated, the locking members 374 are spring elements which each include a forward end 376 secured to a top side of a housing 378 of the rechargeable battery pack 370. As illustrated, the spring elements 374 are formed to include mounting portions 380 which are attached to the housing 378 through threaded fasteners or the like. A central portion 384 of each of the spring elements outwardly extends to engage an associated one of the grooves 55. A rear or free end 386 of each of the spring elements preferably extends beyond the housing 378. In operation, the spring elements 374 are resiliently biased to engage the grooves 55. The ends 386 of the spring elements 374 can be manually grasped and squeezed together to inwardly contract the central portions 384 and thereby allow removal of the rechargeable battery pack 370 from the tool housing.

With particular reference to FIG. 29, a top view of a rechargeable battery pack 400 for use with an eleventh alternative embodiment of the present invention is illustrated. In this embodiment, the rechargeable battery pack 400 is similar to the rechargeable battery pack 16 discussed above and is intended for use with the system 10. Distinct from the rechargeable battery pack 16, the rechargeable battery pack 400 includes a pair of longitudinally extending rails 402 configured to outwardly and inelastically bend the pair of male terminals 86 and 90 upon engagement of the battery pack 400 with the tool 10. In the embodiment illustrated, the rails 402 include forward ramped surfaces 404 intended to engage and deflect the male terminals 86 and 90. The inelastic bending of the male terminals 86 and 90 renders the male terminals 86 and 90 inoperative for future use.

While the invention has been described in the specification and illustrated in the drawings with reference to one or more preferred embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention as defined in the claims. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiments illustrated by the drawings and described in the specification as the best mode presently contemplated for carrying out this invention, but that the invention will include any embodiments falling within the description of the appended claims.

What is claimed is:

1. A system of cordless power tools, comprising:

a battery pack having a battery pack terminal block, a battery and a housing, the battery pack terminal block having a plurality of first terminals that are electrically coupled to the battery, each of the first terminals being associated with a terminal insertion plane, each of the terminal insertion planes being spaced apart from one another in a lateral direction, the housing defining a pair of spaced apart guide rails, a floor and a cavity into which the battery and the battery pack terminal block are disposed, the guide rails defining an insertion axis, the battery pack terminal block being arranged relative to the guide rails such that each of the terminal insertion planes is generally parallel the insertion axis and perpendicular to the floor, the floor being disposed below the first terminals; and

a power tool having a tool terminal block, an electric motor and a tool housing, the tool terminal block having a plurality of second terminals that are electrically associated with the electric motor, the tool housing defining a battery pack mounting aperture and a pair of grooves, the battery pack mounting aperture being configured to receive at least a portion of the battery pack, each of the grooves being configured to receive an associated one of the guide rails when the battery pack is slidingly inserted to the tool housing along the insertion axis;

wherein the guide rails and the grooves cooperate to grossly align each of the second terminals to a corresponding first second terminal and wherein each of the second terminals engages the corresponding one of the first terminals when the battery pack is fully inserted into the tool housing.

2. The system of cordless power tools of claim 1, wherein the power tool is selected from a group consisting of circular saws, reciprocating saws and drill drivers.

3. The system of cordless power tools of claim 1, wherein one of the first and second terminals is a male terminal blade.

4. The system of cordless power tools of claim 3 wherein the other one of the first and second terminals is a female terminal that is configured to engage a pair of opposite faces of the male terminal blade.

5. The system of cordless power tools of claim 1, wherein the battery pack housing includes a pair of housing shells.

6. The system of cordless power tools of claim 5, wherein at least one of the housing shells includes a boss that is configured to engage an aperture formed into a body of the battery pack terminal block.

7. The system of cordless power tools of claim 1, further comprising a latch, the latch being coupled to one of the battery pack and the power tool and operable for releasably engaging the other one of the battery pack and the power tool to thereby releasably secure the battery pack to the power tool.

8. The system of cordless power tools of claim 7, wherein the latch is coupled to and carried by the power tool.

9. The system of cordless power tools of claim 8, wherein the latch engages a recess that is formed in the battery pack housing when the battery pack is inserted into the tool housing.

10. The system of cordless power tools of claim **1**, wherein the battery pack terminal block includes a body, the body including a plurality of spaced apart insulating portions, each of the first terminals being located between an associated pair of the insulating portions.

11. The system of cordless power tools of claim **1**, wherein the tool terminal block includes a body, the body including a plurality of spaced apart insulating portions, each of the second terminals being located between an associated pair of the insulating portions.

12. A system of cordless power tools, comprising:

a battery pack having a terminal block, a battery and a housing, the terminal block of the battery pack having a plurality of first terminals that are electrically coupled to the battery, each of the first terminals being associated with a terminal insertion plane, each of the terminal insertion planes being spaced apart from one another in a lateral direction, the housing defining a cavity into which the battery and the terminal block of the battery pack are disposed, the terminal block of the battery pack being arranged such that each of the terminal insertion planes is disposed generally parallel an insertion axis;

a power tool having a terminal block, an electric motor and a tool housing, the terminal block of the power tool having a plurality of second terminals that are electrically associated with the electric motor, the tool housing defining a battery pack mounting aperture that is configured to receive at least a portion of the battery pack;

a pair of guide rails associated with one of the battery pack and the power tool, the terminal block of the one of the battery pack and the power tool being disposed between the guide rails; and

a pair of grooves associated with the other one of the battery pack and the power tool, each of the grooves being configured to slidingly receive an associated one of the guide rails and wherein the grooves and the guide rails cooperate to grossly align each of the second terminals to an associated one of the first terminals when the battery pack is slidingly inserted to the tool housing along the insertion axis.

13. The system of cordless power tools of claim **12**, wherein the power tool is selected from a group consisting of circular saws, reciprocating saws and drill drivers.

14. The system of cordless power tools of claim **12**, wherein one of the first and second terminals is a male terminal blade.

15. The system of cordless power tools of claim **14**, wherein the other one of the first and second terminals is a female terminal that is configured to engage a pair of opposite faces of the male terminal blade.

16. The system of cordless power tools of claim **12**, wherein the battery pack housing includes a pair of housing shells.

17. The system of cordless power tools of claim **16**, wherein at least one of the housing shells includes a boss that is configured to engage an aperture formed into a body of the battery pack terminal block.

18. The system of cordless power tools of claim **12**, further comprising a latch, the latch being coupled to one of the battery pack and the power tool and operable for releasably engaging the other one of the battery pack and the power tool to thereby releasably secure the battery pack to the power tool.

19. The system of cordless power tools of claim **18**, wherein the latch is coupled to and carried by the power tool.

20. The system of cordless power tools of claim **19**, wherein the latch engages a recess that is formed in the battery pack housing when the battery pack is inserted into the tool housing.

21. The system of cordless power tools of claim **12**, wherein the battery pack terminal block includes a body, the body including a plurality of spaced apart insulating portions, each of the first terminals being located between an associated pair of the insulating portions.

22. The system of cordless power tools of claim **12**, wherein the tool terminal block includes a body, the body including a plurality of spaced apart insulating portions, each of the second terminals being located between an associated pair of the insulating portions.

* * * * *